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INCOMMANDS TDP: Human factors design and evaluation guide

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Abstract

The Innovative Naval COMbat MANagement Decision Support (INCOMMANDS) Technology Demonstration Program (TDP) seeks to research, demonstrate and evaluate new command decision support concepts for the HALIFAX Class frigate's command and control (C2) system, with the objective of improving team battlespace awareness and increasing decision speed and accuracy. This work necessitates the design, development and evaluation of innovative Operator Machine Interface (OMI) concepts to support the operator's interaction with the command decision support concepts developed by the project team. The aim of this document is to incorporate recommended standards and guidelines that should guide and inform the design of OMI and decision aiding concepts developed within the INCOMMANDS project so that they are consistent with human factors best-practice. The document includes guidance on creating a common look and feel that is compatible with existing systems, yet accommodates new developments and knowledge and the design and implementation of decision aids that are both useful and useable. In addition, guidance is provided on the selection of metrics and tools for the evaluation of both the OMI and decision aids for compliance.

Résumé

Le programme de démonstration technologique (PDT) du concept INCOMMANDS (Innovative Naval COMbat MANagement Decision Support, ou Système novateur d'aide à la décision pour la gestion du combat naval) vise à étudier, à démontrer et à évaluer de nouveaux concepts d'aide aux décisions de commandement pour le système de commandement et de contrôle (C2) de la frégate de classe HALIFAX, dans l'intention d'améliorer la connaissance collective de l'espace de bataille et d'augmenter la rapidité et la justesse des décisions. Ces travaux exigent la conception, l'élaboration et l'évaluation de principes novateurs d'interface opérateur-machine (IOM) pour appuyer l'interaction de l'opérateur avec les concepts d'aide aux décisions de commandement élaborés par l'équipe du projet. Ce document a pour but d'intégrer des normes et des lignes directrices recommandées, qui guideront et façonneront l'élaboration des concepts d'IOM et d'aide à la décision arrêtés dans le cadre du projet INCOMMANDS de sorte qu'ils correspondent aux meilleures pratiques des facteurs humains. Le document intègre des lignes directrices en vue de la création d'une présentation uniforme qui soit compatible avec les systèmes existants, tout en tenant compte des derniers développements et de l'état des connaissances pour la conception et la mise en œuvre d'aides à la décision à la fois utiles et utilisables. On y trouve également des lignes directrices sur le choix des indicateurs et des outils permettant d'évaluer la conformité de l'IOM et des aides à la décision.

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Executive summary

INCOMMANDS TDP: Human factors design and evaluation guide:

Sharon McFadden; DRDC Toronto TR 2009-062; Defence R&D Canada – Toronto; May 2011.

Introduction or background: The purpose of the Innovative Naval COMbat MANagement Decision Support Technology Demonstration Program (INCOMMANDS TDP) is to develop, demonstrate, and evaluate advanced Above Water Warfare (AWW), Threat Evaluation and Weapons Allocation (TEWA) command decision support concepts (i.e., decision aids) for the command team of the Halifax Class Frigate in order to improve overall decision-making effectiveness. This work necessitates the design, development and evaluation of innovative Operator Machine Interface (OMI) concepts to support the operator's interaction with the command decision support concepts developed by the project team.

The purpose of this document is to inform and guide the design and development of Electronic Support System (ESS) and OMI design concepts explored within the INCOMMANDS TDP. The specific objectives are:

- To incorporate recommended standards and guidelines that will inform the design of OMI and decision aiding concepts developed within the INCOMMANDS project so that they are consistent with Human Factors best-practice, compatible with existing military OMI guides, and employ an interface style with which operators are familiar;
- To provide common human factors design guidance for existing decision aids, decision aids under development, and future decision aiding concepts within the context of Maritime command and control (C2), including TEWA; and,
- To provide general guidance, in terms of suggested metrics and tools, for the evaluation of a proposed OMI's and ESS's compliance with the guidelines.

Results: This document is largely an integration of the COMmand Decision Aiding technology (COMDAT) OMI Style Guide [1] and the INCOMMANDS decision support guidelines [2]. It is comprised of 24 sections. The first six sections provide background and supporting material as well as high level design guidance. Each of the remaining sections is devoted to a specific area of design. A unique component of this guide is the inclusion of recommended measures and methods for evaluating whether or not the ESS and OMI are compliant with the guidelines.

Significance: Consistent decision support and OMI design within and across systems contributes to enhanced usability. This guide provides the development team with a way to ensure design consistency within a system and with systems fielded in similar naval environments. The benefits of consistency and interoperability between systems include reduced development and training costs and more usable decision support systems.

Future plans: The guidance within this document does not present detailed design solutions or exact specifications. These will be developed and evaluated by the development teams using, in part, the evaluation criteria provided in here. As successful solutions are developed, they should

be captured as design specifications and added to the guidance provided in this document. Moreover, it is recommended that project managers developing decision aids for Maritime C2 systems refer to the guidance presented in this document. In doing so, consistency across C2 systems within the naval environment should be achieved.

Sommaire

PDT INCOMMANDS : Guide de conception et d'évaluation des facteurs humains

Sharon McFadden; DRDC Toronto TR 2009-062; R et D pour la défense Canada – Toronto; Maye 2011.

Introduction ou contexte : Le programme de démonstration technologique (PDT) du concept INCOMMANDS (Innovative Naval COMbat MANagement Decision Support, ou Système novateur d'aide à la décision pour la gestion du combat naval) vise à élaborer, à démontrer et à évaluer des concepts avancés d'aide aux décisions de commandement en situation de guerre de surface et d'évaluation de la menace et de désignation des armes (TEWA) (autrement dit les aides à la décision) accessibles à l'équipe de commandement de la frégate de classe HALIFAX, afin d'améliorer l'efficacité générale du processus décisionnel. Ces travaux exigent l'élaboration et l'évaluation de concepts novateurs d'interface opérateur-machine (IOM) pour appuyer l'utilisation par l'opérateur des concepts d'aide aux décisions de commandement élaborés par l'équipe du projet.

Ce document vise à étayer et à orienter la conception et l'élaboration du système de soutien électronique (SSE) et les concepts d'élaboration de l'IOM examinés dans le cadre du PDT INCOMMANDS. Les objectifs sont précisément les suivants :

- Intégrer des normes et des lignes directrices recommandées qui guideront et façonneront l'élaboration des concepts d'IOM et d'aide à la décision élaborés dans le cadre du projet INCOMMANDS de sorte qu'ils correspondent aux meilleures pratiques des facteurs humains, qu'ils soient compatibles avec les guides militaires existants sur l'IOM et qu'ils emploient une interface avec laquelle les opérateurs sont familiers;
- Assurer une direction commune en matière de conception ergonomique en ce qui touche les aides à la décision actuelles, les aides à la décision en conception et les concepts d'aide à la décision futurs dans le contexte de commandement et de contrôle (C2) de la Marine, ce qui comprend l'évaluation de la menace et la désignation des armes (TEWA);
- Fournir des directives en ce qui touche les indicateurs et les outils servant à évaluer dans quelle mesure l'IOM et le SSE proposés sont conformes aux lignes directrices.

Résultats : Le document intègre en grande partie le guide sur l'IOM de la technologie d'aide à la décision de commandement (COMDAT) [1] et les lignes directrices concernant l'aide à la décision INCOMMANDS [2]. Il comporte 24 sections. Les six premières sections fournissent des renseignements de base et des éléments d'appoint, ainsi que des directives de haut niveau en matière de conception. Chacune des autres sections porte sur un domaine conceptuel en particulier. Une caractéristique unique de ce guide est l'inclusion d'indicateurs et de méthodes recommandés permettant d'évaluer si le SSE et l'IOM sont conformes aux lignes directrices.

Portée : Des concepts uniformisés d'aide à la décision et d'IOM facilitent l'utilisation des systèmes. Ce guide procure à l'équipe de développement un moyen d'assurer l'uniformité conceptuelle au sein d'un système aussi bien qu'entre les systèmes mis en place dans des

environnements maritimes semblables. L’uniformité et l’interopérabilité entre les systèmes procurent entre autres l’avantage de réduire les frais de développement et de formation et de rendre l’appui décisionnel plus convivial.

Recherches futures : Ce document ne présente pas de solutions conceptuelles détaillées ni de spécifications précises. Celles-ci seront élaborées et évaluées par les équipes de développement, qui se fonderont en partie sur les critères d’évaluation énoncés dans le document. Au fur et à mesure que des solutions utiles seront élaborées, on devrait les noter en tant que spécifications conceptuelles et les ajouter aux lignes directrices figurant dans ce document. Par ailleurs, il est recommandé que les gestionnaires de projet qui élaborent des aides à la décision destinées aux systèmes C2 de la Marine se reportent aux lignes directrices figurant dans ce document. On devrait ainsi réussir à uniformiser tous les systèmes C2 du milieu maritime.

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1 Introduction

1.1 Background

The purpose of the Innovative Naval COMbat MANagement Decision Support Technology Demonstration Program (INCOMMANDS TDP) is to develop, demonstrate and evaluate advanced Above Water Warfare (AWW) Threat Evaluation and Weapons Allocation (TEWA) command decision support concepts (i.e., decision aids) for the command team of the Halifax Class Frigate in order to improve overall decision-making effectiveness.

A central premise underlying the INCOMMANDS TDP is that Canadian warships will be required to have advanced and innovative command and control (C2) decision aid capabilities that will improve operator decision-making effectiveness in the context of TEWA. Advances in threat technology, the increasing difficulty and diversity of air, land, open-ocean, and littoral scenarios, and the volume of data and information to be processed under time-critical conditions pose significant challenges to tactical C2, in particular TEWA. The dynamic environment in which these activities are conducted is one of high risk and stress as it includes organised, intelligent, lethal threats. It is also inherently uncertain due to the imprecise and incomplete nature of sensor data and intelligence, which places variable and unpredictable demands on decision makers. These and other factors lead to increased demands for time-pressured decision making in ambiguous tactical situations. They also contribute to a rapidly growing data overload problem for a ship's Command Team. Hence the objective of the INCOMMANDS TDP is to improve team battlespace awareness, and increase decision speed and accuracy under high-workload, high-stress, and uncertain conditions. The intention is that the decision aiding concepts will present information and provide decision recommendations in such a way as to reduce the mental demands placed on an operator. This necessitates the design, development, and evaluation of innovative Operator Machine Interface (OMI) concepts to support the operator's interaction with the proposed decision support concepts.

1.2 Objectives

The goal of this document (hereafter called the "Guide") is to inform and guide the design and development of the Electronic Support Systems (ESS) and OMI design concepts explored within the INCOMMANDS TDP. In order to achieve this goal, the objectives are as follows:

- To incorporate recommended standards and guidelines that will inform the design of OMI and decision aiding concepts developed within the INCOMMANDS project so that they are consistent with Human Factors best-practice, compatible with existing military OMI guides, and employ an interface style with which operators are familiar;
- To provide common OMI design guidance for existing decision aids, decision aids under development, and future decision aiding concepts, within the context of Maritime C2, including TEWA; and,
- To provide general guidance, in terms of suggested metrics and tools, for the evaluation of a proposed OMI's and ESS's compliance with the guidelines.

1.3 Scope of document

This document does not present detailed design solutions or exact specifications. As well as proving to be technically difficult, time consuming and prone to obsolescence over time, to do so would inhibit the creative scope of the development team. Instead, this document presents generic guidance to support the development of ESS and OMI design concepts. The detailed design solutions will be developed and evaluated by the development teams using, in part, the evaluation criteria provided in this document. As successful solutions are developed, they should be captured as design specifications and added to the guidance provided in this document. Finally, future Maritime C2 projects should refer to the guidance presented in this document. In doing so, consistency across all systems that are developed should be achieved.

1.4 Organization of the Guide

The Guide is comprised of 24 sections. The overall organization is as follows:

- Sections 1 through 6 provide background and supporting material.
- Sections 6 through 24 comprise the body of the Guide.

Each of the guidance sections is devoted to a specific area of design. Since the Guide is an integration of the COMmand Decision Aiding Technology (COMDAT) OMI Style Guide [1] and the INCOMMANDS decision support guidelines [2], the organization of the different sections and of the guidelines within a section are not identical.

1.4.1 Guideline format

Each guideline topic contains the following information:

- **Guideline number**. A unique reference number given to each guideline, or set of guidelines, to enable rapid search for a particular guideline (e.g., 7.1.1).
- **Guideline title.** A short title that summarizes the topic of the guideline(s) (e.g., Employ operator centered principles).
- **Guideline(s).** A list of guidelines relevant to the topic.
- **Source.** A reference for the source document(s) from which the guideline(s) was (were) taken. The full reference for each source is shown in Section 3 and in the reference list at the end of the document.
- **Discussion.** Where relevant, supporting evidence, caveats, and/or further discussion of the guidelines are presented in this section. If a paragraph within the discussion applies to a specific guideline, the paragraph is labelled **“**Gx” where x is the guideline number.
- **Evaluation methods and measures.** Evaluation methods and measures are provided that will enable the developer to demonstrate compliance with the guideline(s). These measures are described in Section 6.
- **Relationship to other guidelines.** Relevant guidelines (and the Guideline Number) to the topic are presented here. Cross-referencing should make it less likely that related guidelines are overlooked.

1.5 Conventions used in this style guide

1.5.1 Terminology

1.5.1.1 Use of *Shall* Versus *Should*

Many guideline documents draw a distinction between mandatory (or *shall)* provisions, and recommended (or *should*) provisions. All of the provisions in this document are written as mandatory and use *shall*. The intent of the language is not to imply that all guidelines presented in this document are required. The intent is that the system developer follows the guidelines presented herein if the design uses a feature described in this document. The language of *shall* rather than *should* was chosen for historical contractual reasons. Historically, and often by training, developers focus on the required provisions and avoid guidance that is not required.

1.5.1.2 Operators versus users

Throughout this document the terms *Users* and *Operators* are used interchangeably to refer to the crewmembers that operate the Command and Control System (CCS). The terms users and operators do not refer to members of the design or engineering team.

1.5.1.3 Use of term Electronic Support System (ESS)

Given the propensity of computer-based systems that assist the operator in a myriad of mental and physical activities (e.g., decision making aids, decision aids, automation, adaptive automation, intelligent automation, intelligent adaptive interfaces, expert systems, knowledge-based systems, data fusion, and information fusion) to varying degrees of autonomy (e.g., tool, aid, associate, autonomous agent) and sophistication (e.g., assistant, associate, or coach), the generic term *Electronic Support System (ESS)* has been used in this document to refer to all of the systems, and similar systems, that are cited above. An electronic support system is defined as:

- A sophisticated computer-based system, which embodies domain expertise, used to assist decision makers in:
    - Acquiring, fusing, modelling and displaying information;
    - evaluating and integrating information;
    - Presenting a synthesized picture of the situation;
    - Making decisions; and,
    - Implementing a course of action.

1.5.2 Representation of keys

Representations in this document such as “< >” are used to refer to input device selections (or sequence of selections) assigned to the function described by "< >". Thus, <Shift> means press the Shift key.

1.5.3 Selection of symbology

Throughout the document the provisions call for adherence to the Naval Tactical Data System (NTDS) symbols unless superseded by specified symbology. The intent of the caveat is to identify the possibility that the Canadian Forces may move to STANAG 4420 [3] or Military Standard 2525 (Common Warfighting Symbology) [4] as the common symbology base.

1.6 Use of Microsoft Windows OMI style guide

In Maritime CCSs, the core OMI style has been Open Source Foundation (OSF)/Motif. Developers of Maritime CCSs have been directed to the OSF/Motif style guide and tool kit. Use of the OSF/Motif style guide was intended to promote consistency within applications and to promote interoperability among various defence systems. Consistency among OMIs results in reduced training, fewer errors, and increased effectiveness.

The use of OSF/ Motif styles, does promote and define consistencies among defence systems, but does not build on the lifetime of computer experience of Canadian operators. Computing has changed rapidly over the past several decades. The platform with which most Canadians are familiar is Microsoft Windows. Thus, this Guide follows Microsoft Windows styles. By using the Microsoft Windows styles, the new applications will build on the external (non-military) training that the operators have received. Operators will be able to transfer the learning that they have obtained throughout their previous computer experiences to the INCOMMANDS systems and will not have to learn unique conventions for similar computing functions. The CCS applications will be consistent with the conventions and tools that the operators have already learned during other computing activities.

The migration from OSF/Motif styles to Microsoft Windows styles is not intended to imply the use of a Microsoft operating system. Any operating system may be used. The goal is not to require a specific operating system but instead to produce effective systems with a common look and feel. However, the use of a software development environment that employs frames and widgets consistent with Microsoft Windows styles is recommended.

When the source documents refer to the OSF/Motif styles, the current document has edited the references so that they call out the Microsoft windows conventions. The Microsoft Windows guidelines in their entirety are available commercially [5]. Thus for the most part they are not repeated here. Where necessary, the guidance has been tailored for the unique Maritime CCS requirements.

Appropriate copyright permissions for Motif, Microsoft, or any protected materials should be sought before incorporating copyrighted materials or designs into an OMI.

2 Using the INCOMMDANDS human factors design and evaluation guide

Consistent ESS and OMI design within and across systems contributes to enhanced usability. For reasons discussed in the previous section, the need for consistency in the development of INCOMMANDS decision support systems and interfaces is particularly critical. This Guide provides the development team with a means to ensure consistency within a system and across systems. The benefits of consistency and interoperability between systems include reduced development and training costs and a more usable ESS.

The goal of the Guide is to provide information that permits the developer to build on existing design solutions and operations knowledge while at the same time creating new and effective designs. Thus, it includes high-level design guidance as well as detailed guidance. Unlike most existing design guidance, the Guide includes recommendations on methods for establishing compliance with specified guidelines. Often, compliance is based on a heuristic evaluation of the proposed OMI by a human factors practitioner. While this may be sufficient for assessing specific, well-defined aspects of the OMI design, it is less satisfactory for assessing less prescriptive and more abstract guidance. Examples might include statements such as “the system shall maintain operator situation awareness” or “all colours shall be easily discriminated”. The addition of recommended methods for evaluating compliance makes the Guide more useful to project managers who use it as part of a system specification.

To use the Guide effectively, the processes related to it must be incorporated into the contractor’s existing development processes. The greatest cost benefit will be achieved when the Guide is used from the beginning of the development effort. This includes incorporation of the recommended evaluation processes.

The whole ESS and OMI development team should be aware of the general contents of the Guide. In addition, the team should assign one person to be the lead on the implementation of the guidelines and the evaluation of the design concepts. That person should have a detailed understanding of the guidelines and evaluation methodologies. He/she should be aware of the design solutions developed by the team members and should resolve competing design options so that they are optimized for the operators. Resolving competing design options as they occur reduces the amount of design work required.

Each design solution and evaluation should be documented in a project human factors design and evaluation guide (hereafter called the “Project Guide”). Thus, the Project Guide will evolve to become a description of the design decisions and their relative merits. The Project Guide lead should be responsible for ensuring that the project solutions are consistent with the Project Guide and have been suitably evaluated.

The Guide was developed to be as inclusive as possible. For any given decision support and/or OMI design many sections will not be applicable. If the Project Guide lead determines that a specific section is not applicable to the emerging design, it can be omitted. For example, if the design does not include graphs, guidance on the graph design can be omitted. Any decision to omit a section should be documented. If it is appropriate and works well with the existing corporate processes, documentation of decisions can be treated in much the same way as a compliance matrix for other requirements.

The Guide can be formatted in an abbreviated table format with additional columns as required beside each item in the guide as is done in a compliance matrix. The disposition of each item can be documented in the column alongside the style guide item. The project office can use a dedicated column for comments, questions, or to sign off on any agreed deviations. The contractor should use a process to implement the Guide that works well with the entire corporate development process. Using the corporate process, the disposition of each item in the Guide should be documented. If a design solution is reached that is not addressed in the Guide, the solution and the supporting evaluation method should be added to the Project Guide. Conflicts between the Guide and the Project Guide should be resolved between the project office and the contractor's team. Similarly, the project office should review any additions to the Project Guide that are not addressed in the Guide.

Development of new designs and technologies is rapid. It is not possible to predict all of the new and effective design options that will be developed. The Guide is intended to support design creativity, not to limit it. As new technologies and decision support concepts are developed they should be tested for usability within the complete operational context using the methodologies recommended in the Guide. Successful solutions should be captured as part of the specific design being developed. If, for example, an operationally effective 3-dimensional (3D) display is developed, then both the Guide and the Project Guide should be updated with guidelines covering the elements of that display that make it effective. For the purposes of the project, the design team, whether that team is comprised of a single designer or a larger team, will have a documented reference, so that throughout the project, any 3D displays will have the same look and feel.

3 Source documents

The COMDAT OMI Style Guide [1] and the INCOMMANDS decision support guidelines [2] integrated guidance from multiple documents and tailored them for use in the development and evaluation of prototype CCSs such as the INCOMMANDS Technology Demonstrator (TD). A list of these source documents is provided below. As part of the tailoring process, statements from the different source documents have been incorporated as originally written or have been modified as appropriate for the Canadian operating environment or to reflect more recent research. Thus, citation of a source does not imply that the originators of the sources have read or approved of the statements or provisions presented in this guide.

The knowledge base from which these guidelines have been extracted varies extensively in its reliability and depth. In some cases, especially with the OMI guide, the guidelines are based on multiple studies and/or extensive experience. In other cases, such as guidelines for ESS or complex displays, the knowledge base is less mature and many of the guidelines have not been substantiated by experience. To provide the reader with an estimate of the quality of the guidance, the source documents are organized by type of publication. In some instances, the information in the original COMDAT OMI Style Guide was derived from specialized professional knowledge and a review of the COMDAT TD. In such cases, the supporting documents may not be available for referral or may represent generally accepted human factors professional knowledge. In those instances, Unger Campbell and Associates, the corporate author of the COMDAT OMI Style Guide is cited as the source.

The documents listed in Table 1 are cited within the body of the report using the acronyms in column one. One primary source document for the OMI guidance was the *Theater Battle Management Human Computer Interface Specification* (TBM) [6]. Throughout TBM, the original source documents were also cited. The *COMDAT OMI Style Guide* retained the source references identified in TBM (rather than citing TBM as the primary source). However, many of those sources are no longer available. Thus, this guide cites TBM. The COMDAT OMI Style Guide or TBM can be consulted if further details about the original source of the information are required.

Table 1: List of source documents

Acronym	**Document Title**
Military standards	
DEFSTD25	Ministry of Defence (1987), Human factors for designers of equipment, (Def Stan 00-25 (Part 1) Issue 2), Ministry of Defence, Whitehall, London, U.K. [7]
MH761	Department of Defense (1989). Human engineering guidelines for management information systems, (MIL-HDBK-761A), Department of Defense, Washington, D.C. [8]
MS1472F	Department of Defense (1999), Department of Defense Design Criteria Standard: Human Engineering, (MIL-STD-1472F), Department of Defense, Washington, D.C. [9]
Commercial standards	

Acronym	Document Title
MSWUE	Microsoft Corporation (1999), *Microsoft Windows user experience: Official guidelines for user interface developers and designers*, Redmond, WA: Microsoft Press. [5]
Book chapters	
Endsley96	Endsley, M. D. (1996), Automation and situation awareness, In R. Parasuraman and M. Mouloua (Eds.), *Automation and Human Performance: Theory and Applications* (pp. 163-181).Mahwah, NJ: Lawrence Erlbaum. [10]
Nielsen94	Nielsen, J. (1994), Heuristic Evaluation, In Nielsen, J., and Mack, R.L. (Eds.), *Usability Inspection Methods*, John Wiley & Sons, New York, NY. [11]
Zachary97	Zachary, W. W. and Ryder, J. M. (1997), Decision support systems: Integrating decision aiding and decision training, In M. G. Helander, T. K. Landauer, and P. V. Prabhu (Eds.), *Handbook of Human-Computer Interaction*, pp 1235-1258. Amsterdam, The Netherlands: Elsevier Science B.V. [12]
Technical reports	
AHCI	Toms, M., Williamson, J., and Cone, S. (1998), Aviation Human-Computer Interface (AHCI) Style Guide, (Report No. 64201-97U/61223), Veridian, Veda Operations, Dayton Ohio. [13]
CSFAB	Osga, G. and Kellmeyer, D. (2000), Combat Systems Functional Allocation Board Human-System Interaction (HSI) style guide. Version 1.0, (Draft) Space and Naval Warfare Systems Command, San Diego, CA. [14]
DISA	Defense Information Systems Agency (1994), Department of Defense Technical Architecture Framework for Information Management: Volume 8: Department of Defense HCI Style Guide, Defense Information Systems Agency, Washington, D.C.[15]
Handbook 5	MONIME AHWG of the AUSCANNZUKUS C3 Committee (1997), Handbook 5: Guidelines for Maritime Information Management, AUSCANNZUKUS. [16]
HFDATC	Cardosi, K. M. and Murphy, E. D. (1995), Human factors in the design and evaluation of air traffic control systems, (DOT/FAA/RD-95/3; DOT-VNTSC-FAA-95-3), John A. Volpe National Transportation Systems Center, Cambridge, MA.[17]
HFDS	Ahlstrom, V. and Longo, K. (2003), Human Factors Design Standard (HFDS) for acquisition of commercial off-the-shelf subsystems, non-developmental items, and developmental systems, (DOT/FAA/CT-03/05; HF-STD-001), U.S. Department of Transportation, Atlantic City, NJ. [18]

Acronym	Document Title
NOSTP	Canadian Forces Naval Operations School (2001), Naval operations school training publication. (NOSTP 200B), Maritime Command. [19]
R/SAOC	Unger Campbell, G. (1996), NORAD R/SAOC Modernization Project. Human factors usability review, (DCIEM-96-CR-21), Unger Campbell and Associates, Delta, BC. [20]
TBM	Bowen C. D. (1994), Theatre Battle Management Human Computer Interaction (HCI) Specification, (MP 94B0000036), MITRE, Bedford MA. [6]
Journal articles	
Endsley99	Endsley, M.R. and Kaber, D.B. (1999), Level of automation effects on performance, situation awareness and workload in a dynamic control task, *Ergonomics*, *42(3)*, 462-492. [21]
Parasuraman97	Parasuraman, R. and Riley, V. (1997), Humans and automation: Use, misuse, disuse, abuse, *Human Factors*, *39*(2), 230-253. [22]
Sheridan00	Sheridan, T.B. (2000), Function allocation: algorithm, alchemy or apostasy? *International Journal of Human-Computer Studies*, *52*, 203-216. [23]
Conference proceedings	
Hutchins99	Hutchins, S.G., Morrison, J.G., and Kelly, R.T. (1999), Principles for aiding complex military decision making. In *Proceedings of the Second International Command and Control Research and Technology Symposium.* Monterey, CA. [24]
Other	
UCA	Unger Campbell and Associates, human factors, usability, and domain expertise.

4 Design decision filters

The design decision filters are the system characteristics that determine how general OMI guidelines are defined for a specific system. Design decision filters include the characteristics of the user population, the physical environment, and the devices used to access the software.

4.1 User population

This document is intended for developers who develop software, technical demonstrators, or prototypes to be used by Maritime CCS operational personnel. However, it is intended to support operational personnel without advanced software skills. They will have training on the system but the training should not be used to compensate for poor design.

4.2 User skills and experiences

Operators of the INCOMMANDS system will have a range of experience from novice crewmembers to veterans with many years of experience. Familiarity with a system, frequency of use, and training all affect the design. The design team should ensure that all levels of operator expertise are supported and that support for one level of expertise does not interfere with the performance of operators with different levels of expertise.

4.3 Physical environment

The working environment impacts the system design. The working environment for INCOMMANDS is a shipboard operations room. Examples of design considerations resulting from the working environment are presented below:

- **Colours.** Screen colours chosen must be compatible with both low ambient operations room lighting and with the red lighting used to maintain dark adaptation.
- **Font size**. Font sizes must be larger than is required for a normal office environment.
- **Cursor targets.** The shipboard environment is subject to motion; accordingly, the pointing device and on-screen target areas for the cursor must be large so that fine motor control is not required.

5 High level design guidance

The OMI and ESS are aspects of a system's design that directly affect user experience. Good OMI and ESS designs incorporate all of the necessary functionality, improve operational effectiveness, and are easy to learn. Conversely, poor designs are difficult to use, induce user errors, reduce operational effectiveness, and increase the operator training requirements.

The designer has multiple ways to implement system functionality. The challenge is to incorporate these options into an overall design that results in a good OMI and effective decision support. Both should integrate the operator with the system and achieve the following goals:

- Consistency
- Interoperability
- Usability

5.1 Consistency

One of the major goals of the Guide is to enforce consistency. Consistency is not just a question of interface design but includes ensuring that the system's tasks and structure match the operator's tasks and decision making processes. Successful C2 relies on information being presented in a manner that contributes to the operators' knowledge of the tactical situation; the ability to access information and to convert it to knowledge is enhanced if the OMI is consistent. OMI design consistency permits the operators to attend to the information supplied by the system rather than to the system itself [25]. If the OMI is consistent throughout the application, and with other computer experiences, operators do not need to devote attention to details of operating the software controls and displays. Instead, cognitive processing is focused on the tactical information. Each instance of inconsistency is likely to produce unnecessary cognitive processing and affect the cognitive processing available to the decision maker for the actual combat tasks. The INCOMMANDS OMI therefore shall be designed to be consistent; appearing, behaving and responding the same throughout. The following types of consistency shall be considered:

- **Consistency with the current Halifax Class CCS.** Platform conventions shall be followed where practical.
- **Consistency with existing military human factors standards.** These include but are not limited to MIL-STD 1472F [9], DEF-STD-00-25 [7], and MIL-HDBK-46855A [26].
- **Visual consistency (general OMI layout "look and feel").** The same information shall be presented in the same location on all screens and dialogue boxes and it shall be formatted in the same way to facilitate recognition. Menus shall be presented in a consistent format throughout the system and shall be readily available at all times.
- **Consistency with operator expectations.** Display-control relationships must be compatible with the operator's expectations, and require minimal processing to extract the information from the system [25]. Operators who have been trained on a software system, or who use a system's controls frequently, access the controls by the location of the controls rather than by the labels *per se*. The labels and icons are used to confirm the identity of the control rather than to locate them. Operators expect specific functions to be located in known locations on the display. There is a negative transfer of training if the controls are not located in consistent places. Negative transfer is particularly severe if the overall look or

placement of the controls in the systems is similar, but not identical. Under those conditions, operators expect to find the controls in the locations in which they are found on the first system used. Unless the operator has used the new systems repeatedly and frequently, under stressful conditions he or she will revert to reacting as if the controls are in the expected locations for the first system used.

- **Consistency with the decision maker's mental representation.** The problem representation within the decision aid shall reflect the problem representation, cognitive strategies, expectations, and work practices of the decision maker.
- **Consistent language/terminology.** Operators should not have to wonder if different words, situations, or actions mean the same thing. Small changes in the language lead to errors and confusion. Operators assume that different terms reflect differences in the software. For example, the term "Close" is expected to result in a different action than "Exit" so these shall not be used to label the same action. Conversely, if more than one term is used to convey the same concept, then the operator must determine if the different terms reflect the same or a different software activity. For example, an application may incorrectly use three notations: "Stop", "Cease", and "End" each to mean that the processing will not be continued (e.g., identical terminology shall be used in prompts, menus, and help screens).
- **Consistent symbols and icons.** Using more than one icon design to represent instances of a single type of control will lead to errors and confusion. For example, using a door icon and an "X" symbol both to indicate "Close" in an application will lead the operator to assume that the "X" and the door icon operate differently. Similarly, differences in choices of track or symbology colour (reversing the colour code for Friend and Hostile, for example) will inevitably lead to errors.
- **Feedback consistency.** The interface shall have a reliable and consistent method of system response across applications. Transactions made by the operator shall produce a consistent perceptual response whether it is in visual, tactile, or auditory form.

5.2 Interoperability

Maritime CCSs must be seamlessly interoperable. Crewmembers are expected to work with many C2 systems over the course of their careers. Differences in the OMI layouts of the systems, the controls, navigation, or presentation can create delays, errors, and confusion. Thus the overall design should be as consistent as possible with other systems that the operator will be using. This recommendation is not intended to inhibit innovative design concepts especially if they overcome flaws or limitations in the current systems. However, the introduction of new concepts should be based on proof that the advantage in terms of reduced training, workload and more efficient interaction with the system more than offsets the requirement to learn a new way of doing business.

5.3 Usability

Throughout this guide, the paramount goal is to promote usability. The following heuristics are considered to be basic requirements for complex operator interfaces and, as such, can be used as over-arching recommendations in implementing the specific guidelines provided in the remaining sections. They have been compiled from the source documents listed in Section 3 as well as Nielsen [11]:

- Software and equipment interfaces shall provide a functional interface between the system for which they are designed and users (operators/maintainers) of that system. The OMI shall optimize compatibility with personnel and shall minimize conditions that can degrade human performance or contribute to human error.
- The system shall always keep operators informed about what is going on, through appropriate feedback. Within reason, every input by a user shall consistently produce some perceptible response output from the computer.
- The system shall minimize cognitive workload by maximizing the use of similar procedures.
- The system shall maximize the relevance of human-computer dialogue to the operator's job and the use of standard and consistent human-computer dialogue.
- The system shall speak the operators' language, with words, phrases and concepts familiar to the operator, rather than system-oriented terms. Real-world conventions shall be followed to make information appear in a natural and logical order.
- Undo and redo functionality shall be supported where practical. Operators often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue.
- The system should minimize the frequency and significance of user error and maximize the ease of error recovery. When errors do occur, <u>appropriate</u> alarms and alerts shall be presented to the operator. Error messages shall be expressed in plain language, precisely indicate the problem, and constructively suggest a solution.
- Objects, actions, and options shall be visible to the operator at all times. The operator shall not have to remember information from one part of the dialogue to another. Instructions for use of the system shall be visible or easily retrievable whenever appropriate.
- The design shall promote efficiency of use by minimizing:
  - the necessity for the operator to shift hands between the keyboard and other input devices,
  - cursor travel requirements across/between display(s),
  - switching of visual focus between different displays and windows during a procedure,
  - the number of steps within a procedure, and
  - the amount of window sizing, placement and manipulations.
- The system shall promote flexibility of use through the use of accelerators (e.g., hot-keys), which are unseen by the novice operator, to speed up the interaction for the expert operator. In this way, the system can cater to both inexperienced and experienced operators.
- The sequence of transaction selection shall generally be dictated by user choices and not by internal computer processing constraints. Operators shall also be allowed to tailor how they perform frequent tasks (e.g., re-configure windows) and shall be able to manipulate data without concern for internal storage and retrieval mechanisms of the system.
- Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information shall be easy to search, be focused on the operator's task, list concrete steps to be carried out, and not be too large.

- When the operators must make similar decisions, the decisions shall be supported in the OMI within the same logical model. For example, models to filter information can be described in two ways. One model is described as filtering information out; the other as passing information through. To avoid confusion, the OMI must follow a single model.

6 Evaluation methods and measures

A unique component of this Guide is the inclusion of recommended measures and methods for evaluating whether or not the ESS and OMI are compliant with the guidelines. All projects usually include some form of quality assurance. This may involve systematic testing of the individual components and the overall system to ensure that the hardware and software work as specified. In addition, it is becoming increasingly important to ascertain that the system can be used effectively and efficiently by the human operator in order to achieve mission goals. Thus, in addition to providing guidance on the design of the OMI and ESS, it is important to provide guidance on the evaluation of the system for compliance with the guidelines. Therefore, the Guide includes methods and measures for assessing the compliance of the ESS and OMI.

To assist the developer in the evaluation process, this section provides a description of the various measures and methods cited throughout the guide as well as some specific tests for evaluating some of the measures such as situation awareness (SA) and workload. The specification of exact criteria to which the components of the OMI are evaluated against (e.g., the extent to which the OMI affords adequate SA or workload levels) will depend on the specific design and the tasks and goals of the operator. Thus specific measures of performance (e.g., time taken to hook a track or assess its threat level) will be derived from a formal function and task analysis including a cognitive task analysis.

As with the evaluation of software and hardware, relevant methodologies for evaluating compliance will vary across different guidelines and across the development process. Typically, evaluation measures can be administered by the following methodologies:

- **Inspection**: This is usually carried out by a person with experience in the human factors of interfaces to determine that OMI elements are compliant with the guidelines. It will likely involve a combination of review (e.g., number of menu items that conform to guidelines) and measurement (e.g., visual angle of fonts) using a detailed check list compiled from the guide.
- **Demonstration**: This will involve a walkthrough of the different system functions to ensure they are compliant with the guidelines (e.g., pop-up windows do not obscure critical tactical information).
- **Experimentation**: This will include modeling or simulation activities as well as human-in-the-loop experimental or questionnaire-based studies to determine that the system promotes efficient and effective performance and is acceptable to the operator.

An overall framework for the human factors evaluation of complex C2 systems can be found in Matthews, Webb, and McCann [27]. The developer should consult it to determine when and how the various measures presented throughout the guide should be used. For a detailed experimentation plan that is consistent with this framework, the reader is referred to the INCOMMANDS Demonstration and Experimental Plan [28]. For the most part, the information provided below is adapted from that document.

6.1 Design verification

During system development, construction, and acceptance the developer should subject the emerging OMI and ESS designs to verification checks that relevant human factors requirements,

methods, and guidelines are being followed. Verification addresses the question: *"Did the developers do the right things?"* Verification tends to be a checklist and review approach conducted by external independent specialists. Verification techniques include expert reviews of

- human factors program plans and scheduling,
- methods employed for various human factors activities (e.g., task analysis),
- suitability and application of feature related guidelines (i.e., compliance with this guide), and
- compliance with the design guidance outlined in Section 5.

Verification is usually done using a combination of inspection and demonstration methodologies.

6.2 System-based measures

System-based measures assess the capabilities of the total system (i.e., operator and machine). The following measures are illustrative of system-based measures of performance:

- Time to detect targets, taken from the time the target was available for detection by the system's sensors to the time of actual threat determination;
- Percentage of targets detected, through a comparison of system-determined targets versus ground truth in any experimental situation;
- Percentage of targets recognized/identified, through a comparison of the identification of detected targets versus ground truth in any experimental situation; and,
- Accuracy of target location of all target detection/recognition/identification, through a comparison of reported positions versus ground truth.

The collection of system-based measures requires at least a working prototype of an operational system. Thus, a demonstration methodology is used.

6.3 Operator-based measures

Unlike system-based measures, operator-based measures assume that hardware and software are working optimally. They assess how well the OMI and ESS support the operator in carrying out tasks effectively and efficiently, provide good SA and optimal workload, and engender appropriate level of trust in the capabilities of the system. For a more detailed discussion of operator-based methods see Hollands [29] and Pina, Donmez and Cummings [30].

Since all operator-based measures must take into account individual differences, some form of experimental methodology is required.

6.3.1 Operator performance

Operator performance measures assess how easy it is for an operator to use the various components of the interface and ESS to carry out his or her tasks and how useful the available features and function.

6.3.1.1 Speed of task completion

Measurement of task performance speed can be used to provide an objective measure of operator performance for pre-defined sequences of events (e.g., time taken to detect target, time taken to identify target, time taken to apply combat power). Determination of task performance speed can be measured manually by means of a stopwatch during real time or later by means of video analysis. Task performance speed can also be determined automatically through the insertion of a marker in the prototype evaluation software to mark pre-defined task start times.

6.3.1.2 Accuracy of task performance

Measurement of task performance accuracy can be used to provide an objective measure of operator performance of pre-defined sequences of events (e.g., correct target identification, correct ranking of threat priority, correct application of combat power). Determination of task performance accuracy can be measured by comparing test participant performance and output against pre-determined performance criteria. However, the interpretation of such data can be difficult. For a more complete discussion of accuracy assessment see Hollands [29].

6.3.2 Operator decision making quality

One difficulty with conducting research on operator decision making is deciding how performance is defined. Research to-date has been dominated by assessing the quality of a decision by quantifying the value of the outcome for a given event. In many instances, this will be a binary output in terms of a simple correct or incorrect outcome. Unfortunately, such a measure reveals little of the decision processes involved in arriving at a course of action. Thus, it is important to consider decision making in the context of “process” (i.e., how a decision was reached) as well as “outcome” (i.e., what decision was reached). Potential metrics for assessing decision making quality are discussed below. Currently, most of these can only be assessed through direct observation of operator performance, protocol analysis, or probes during scenarios designed to elicit the desired behaviours [29].

6.3.2.1 Situation assessment

Inherent in the “recognition-primed” accounts of decision making is the notion of pattern-matching the mental representation of the situation with past experience. Clearly, the quality of decision making is related to the quality of this mental representation of the situation, which in turn is related to the quality of the processes undertaken to acquire it. Thus, one way of assessing decision quality is to assess the quality of the situation assessment processes underlying the formation of the decision (see Clark, Banbury, Richards and Dickson [31]).

Banbury, Dudfield, Hoermann and Soll [32] developed a questionnaire-based measure to assess the efficacy of the situation assessment processes. The Factors Affecting Situation Awareness (FASA) questionnaire comprises 30 questions, divided into the following five sub-scales: Attention Management (participants’ ability to attend to more than one task at a time and resume a task successfully after being interrupted); Information Management (participants’ motivation to acquire appropriate information to make rational decisions); Cognitive Efficiency (participants’ ability to ignore distractions and maintain SA despite external stressors); Automaticity (participants’ experience performing routine tasks in a highly practiced, automatic way), and

Inter-Personal Dynamics (participants' knowledge of non-verbal communication and their views on what team membership entails).

6.3.2.2 Timeliness and agility

With the nature of modern warfare relying heavily on information quality and supremacy, it has become crucial that operators quickly adapt to the changing context within which they may find themselves. The speed of decision making can be couched in terms of decision "timeliness" (e.g., a change of strategy at the appropriate time) and decision "agility" (e.g., adaptability to changing circumstances). The ability to evaluate timeliness and agility will depend on the scenarios used.

6.3.2.3 Consistency

The consistency of decision making is a useful insight into decision making quality, as it can be argued that differences of outcome from decisions based on the same data could indicate inappropriate or incorrect reasoning processes. Arguably, operators who have made accurate situation assessments and correct inferences based on these data, should reach the same outcome each and every time a similar decision is made.

6.3.2.4 Justifiability and rationality

Justifiability and rationality complement the accuracy measure of decision making quality by providing insight into the underlying processes that led the operator to make a decision. Specifically, operators that make an inaccurate decision may be able to fully justify their choice by providing the rationale behind their decision. The quality of this decision is therefore good, despite its seemingly inaccurate outcome. Further, an accurate decision is not necessarily a good one given that it could have been made by chance alone (i.e., the operator guessed right). If the operator was asked why this decision was made, he/she would not be able to justify it or provide a corresponding rationale. In both cases, accuracy would provide an incomplete and misleading metric of decision quality.

6.3.3 Operator situation awareness

SA is a key determinant of task performance and relates to the ability of the operator to maintain awareness of task-relevant objects in his/her immediate environment. The measurement of SA within the context of the INCOMMANDS TDP is important given the emphasis placed on automation-based technologies. On one hand, these technologies might afford the operator more information than they might otherwise have access to resulting in higher levels of operator SA. On the other hand, it is possible that too much reliance on these automation technologies might have a negative impact of operator's SA because the operator is consigned to monitoring the automation, and not fully engaged in the task. Several different methods have been developed (see Breton, Tremblay, and Banbury for a discussion [33]). Two of the better know methods are discussed below.

6.3.3.1 Situation Awareness Global Assessment Technique (SAGAT)

The Situation Awareness Global Assessment Technique (SAGAT) [34, 35] is an objective measure of situation awareness. It employs periodic, randomly timed freezes in a simulation

scenario during which all of the operators displays are temporarily blanked. At the time of the freeze a series of queries are provided to the operator to assess his or her knowledge of what was happening at the time of the freeze. The queries typically cover three SA levels:

- Perception (i.e., noticing all of the relevant entities in the environment),
- Comprehension (i.e., understanding their meaning), and
- Projection (i.e., anticipating their future states).

Queries are determined based on an in-depth cognitive task analysis that must be conducted for each domain that SAGAT is used in. The questions are typically a random subset of a larger standard set of questions that are relevant to the training scenario. Operator's responses to these queries are scored based on what was actually happening in the simulation at the time of each freeze.

The main advantage of SAGAT is that it allows an objective unbiased index of SA that assesses operator SA across a wide range of elements that are important in a particular system. The main disadvantage of SAGAT is that it requires freezes in the simulation, and as a result, this measure can only be used for laboratory evaluations. Because the freezes are random and cover a broad spectrum of operator SA requirements, operators cannot prepare for the queries. Moreover, it has been found that the freezes do not affect performance in the simulations.

An alternative SAGAT approach is to measure the amount of time it takes operators to report anomalies embedded into the scenario, then note the time it takes them to deviate from the original plan, given the change in circumstances.

SAGAT can also provide insight into crew performance within simulated team environments as well as individual performance. Queries can be designed to assess specific SA requirements for each team member role. More importantly, responses to queries related to common SA requirements can be compared across team members. In addition, specific responses can be compared to determine whether the same responses (correct or incorrect) are made across team member roles. This type of analysis can provide diagnostic information regarding the source of breakdowns in team SA. For example, common incorrect responses may indicate problems that affect the entire team (such as poorly designed information display). Alternatively, a mix of correct and incorrect responses or different incorrect responses across team member roles may indicate a breakdown in team coordination.

6.3.3.2 Situation Awareness Rating Technique (SART)

The Situation Awareness Rating Technique (SART) [36, 37] provides a validated and practical subjective rating tool for the measurement of SA, based on personal construct dimensions associated with SA. The structure of the construct dimensions has been interpreted as comprising of three related conceptual groups, which form the principal dimensions of SART, namely:

- Demand for attentional resources or **D** (complexity, variability, instability);
- Supply of attentional resources or **S** (arousal, concentration, division of attention, spare mental capacity);
- Understanding of the situation or **U** (information quality, information quantity, familiarity).

The most commonly-used version of SART is the 14-dimension version. Instead of numeric Likert-scales, a graphical display of the rating scales is utilized, where the length of a line from the left hand side of the scale to the participant's mark (in millimetres) represents a respective rating score for one item. The possible range is between 0 (low) and 50 (high).

Questions 1, 2, 3 and 4 are averaged to give a **D** score (Demand). Questions 5, 6, 7, 8 and 9 are averaged to give an **S** score (Supply). Questions 10, 11, 12 and 13 are averaged to give a **U** score (Understanding). SA in total (**T**) is then calculated by **U - (D - S)**. Finally, Question 14 gives the participant's confidence in their ratings of the above.

6.3.4 Operator workload

Another key determinant of task performance is the workload experienced by the operator when engaging in tasks. It can be conceptualised in terms of both physical and mental effort. The following section describes a well-validated measure of workload.

6.3.4.1 National Aeronautics and Space Administration – Task Load Index

The National Aeronautics and Space Administration – Task Load Index (NASA-TLX) [38] allows operators to perform subjective workload assessments when working with various human-machine systems. It is a multi-dimensional rating procedure that derives an overall workload score based on a weighted average of ratings on six subscales. These subscales include

- mental demands,
- physical demands,
- temporal demands,
- own performance,
- effort, and
- frustration.

The degree to which each of the six factors contribute to the workload of the specific task to be evaluated, from the operator's perspective, is determined by their responses to pair-wise comparisons among the six factors. Magnitude ratings on each subscale are obtained after each performance of a task or task segment. Ratings of factors deemed most important in creating the workload of a task are given more weight in computing the overall workload score, thereby enhancing the sensitivity of the scale.

The simple nature of the scale permits subjects to provide ratings quickly in any operational settings. The scale can be administered using paper or via a direct operator input program, in real-time or retrospectively. It has been demonstrated that little information is lost when ratings are given retrospectively. The NASA-TLX has been tested in a variety of experimental tasks that range from simulated flight to supervisory control simulations and laboratory tasks (e.g., choice reaction time, critical instability tracking, compensatory tracking, mental arithmetic, mental rotation, target acquisition, grammatical reasoning). It can be used to assess workload in various human-machine environments such as aircraft cockpits, C2 workstations, supervisory and process control environments, simulations, and laboratory tests.

6.3.5 Operator fatigue

Operator performance, as well as general acceptance of the system, will be significantly affected by operational fatigue. It is therefore important to consider the effects of operator fatigue on the system in order to avoid negative outcomes due to fatigue-induced errors (e.g., when monitoring an automated system over extended periods of time). A fatigue rating questionnaire such as the Karolinska Sleepiness Scale [39] provides a simple subjective self report measure of fatigue that can be administered at the same time as other system performance or acceptance measures.

6.3.6 Operator acceptance

The Technology Acceptance Model (TAM) [40] is an information systems theory that models how operators come to accept and use a technology. The model suggests that when operators are presented with a system, several factors will influence their decision about how and when they will use it, notably:

- Perceived Usefulness: This is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance."
- Perceived Ease-of-Use: This is defined as "the degree to which a person believes that using a particular system would be free from effort."

The TAM utilizes a questionnaire that has been assessed for robustness across populations and predictive validity [40]. Studies have found high reliability and good test-retest reliability and that the instrument had predictive validity for intent to use, self-reported usage and attitude toward use. The sum of this research has confirmed the validity of the instrument, and supports its use with different populations of operators and different software choices.

6.3.7 Assessments of system usability and usefulness

A questionnaire relating to the high-level usability aspects of the OMI (e.g., suitability of screen windows, keyboard and joystick) can be used to assess operator perceptions of system usability. Typically, ratings are based on a five-point Likert scale; ranging from 1: Strongly Disagree to 5: Strongly Agree. A similar questionnaire relating to the perceived utility of the workstation functions and capabilities (e.g., drill-down) can be used to assess operator perceptions of system usefulness. The content of the questionnaire will be tailored to the interface. Examples of a usability and a utility question are shown in Figure 1. For detailed guidance on the design of usability and usefulness questionnaires, the reader is referred to Engel and Townsend [41].

Statement	☹ Strongly Disagree	Disagree	Border	Agree	☺ Strongly Agree	Suggested Improvements
1. The size of the …. Window is suitable.	❑	❑	❑	❑	❑	

Statement It is USEFUL to be able to…	☹ Strongly Disagree	Disagree	Border	Agree	☺ Strongly Agree	Suggested Improvements
1. Drill-down to find out more information.	❑	❑	❑	❑	❑	

Figure 1: Examples of questions to assess the usability (top) and utility (bottom) of an OMI

6.3.8 Operator trust

In the context of an ESS, trust can be defined as the extent to which an operator is confident in and willing to act on the basis of the recommendations, actions, and decisions of the ESS [42]. However, trust is not a simple uni-dimensional variable. It is possible to correctly distrust a system (e.g., when it is unreliable), but also to be too trusting (over-trusting or complacent) or not trusting enough (under-trusting or sceptical).

Considerable research has been carried out on operator trust and acceptance of automation. Most of this research involves an indirect assessment of trust based on the extent to which an operator uses an ESS system as a function of its reliability [43-45]. However, only a small number of tools have been developed and evaluated to assess trust directly [30]. One such tool is the human-computer trust scale developed by Madsen and Gregor [42]. With their rating scale, overall trust in the decision aid is determined by cognition-based trust (i.e., trust relating to the operator’s perception of the automation) and affect-based trust (i.e., trust relating to the operator’s emotive response to automation). Three factors underpin cognition-based trust (i.e., perceived understandability, technical competence, and reliability [of the system]), and two factors underpin affect-based trust (i.e., faith [in the system] and personal attachment [to the system]). Although Madsen and Gregory evaluated the reliability and validity of this tool, it is not clear how widely it is used. See Pina [30] for other rating scales for measuring human-computer trust.

7 ESS OMI design guidelines

7.1 General design goals

7.1.1 Employ operator centered principles

1. The ESS shall be used to support the operator(s) where appropriate (e.g., human-centered ESS), not implemented simply because the technology is available (e.g., technology-centered ESS).

2. The ESS shall be designed to match the operator's mental model of the domain as well as the processes underlying system operation.

3. The ESS shall help or enable the operators to carry out their responsibilities and tasks safely, efficiently, and effectively. [Carrying out a task effectively means producing the desired result. Carrying out a task efficiently means that the desired result is produced with a minimum of waste (usually in relation to time)].

4. The operator shall always have final authority over the allocation of ESS functions (i.e., task allocated to human and/or system).

5. Functions shall be automated only to attain greater overall effectiveness, efficiency, reliability, simplicity, economy, and system safety without reducing human involvement, situation awareness, or human performance in carrying out the intended task.

6. The relationships between display, control, decision aid, and information structure and operator tasks and functions shall be clear to the operator.

Source

HFDS, Sheridan00, DEFSTD25, AHCI, DISA, MS1472F, Endsley99.

Discussion

G2. The operator must interpret the information provided to him/her. The operator's training, experience, biases will influence the quality of the decision and execution of their task (s).

G4. The reasoning behind this guideline is twofold. First, it is ultimately the operator who is responsible for the task. Second, ESS automation is subject to failure. Therefore, it is the operator, not the automation, who must be in authority of the system with the automation playing a subservient role.

G5. Automation can lead to distraction from the primary task, increased workload, boredom or complacency.

G6. The operator needs to be able to see clearly how the display or decision aid, and so on, facilitates the completion of the necessary task

Evaluation methods and measures

Design verification:

- Analysis and design methodology are compliant with MIL-HDBK-46855A (Human Engineering Program Process and Procedures) [26].
- Verification of the adequacy of system usability and utility in terms of its design.

Operator performance:

- Objective measure of the adequacy of OMI usability.

Operator acceptance:

- Subjective assessments of the adequacy of operator's perceptions of system usability and utility.

Relationship to other guidelines

7.1.2 Optimize human-system interaction

7.2 Employ operator-centered OMI design

8.2.3 Keep operators in control

23.1 Adopt operator-centered design principles

7.1.2 Optimize human-system interaction

1. The ESS shall provide sufficient information to keep the operator informed of its operating mode, intent, function, and output; inform the operator of system failure or degradation; inform the operator if potentially unsafe modes are manually selected; not interfere with manual task performance; and allow for manual override.

2. ESS system functioning shall be transparent to the operator at all times.

3. The operator shall have active involvement in the operation of the ESS. Operators shall be given an active role through relevant and meaningful tasks in the operation of a system, including when the tasks are automated.

4. ESS functionality shall be appropriate to the operator's level of expertise with the system (e.g., shortcuts such as function keys can be provided for the more experienced operators).

5. ESS functioning shall not increase the demands for cognitive resources (thinking or conscious mental processes).

6. Extreme levels of workload (low or high) due to ESS functioning shall be avoided (to maximize operator-in-the-loop and reduce automation bias).

7. Operator interaction with the ESS shall not require the operator to take significant amounts of attention away from the primary task.

8. The ESS shall not interrupt at inappropriate times such as during periods of high workload or during critical moments in a process.

9. An ESS task shall be less difficult to carry out than the manual task it replaces.

10. Data that are needed by the operator shall be easily accessible.

11. The ESS shall allow the operator to interact directly with objects which are important to the operator's tasks.

Source

HFDS, DISA, Parasuraman97, AHCI, MS1472F, Endsley96, DEFSTD25, Endsley99.

Discussion

G2. The transparency of system functioning (i.e., the properties of the ESS which allow the operator to understand its actions) will increase the predictability of the ESS (e.g., reliability of automatically detecting and prioritizing tracks) by ensuring the operator is cognisant of the limitations of the ESS. In addition, it is very important that operators understand why, and under what conditions, the ESS might make errors. Trust should increase if operators receive informative feedback in the event of an ESS error (e.g., explanation of system error). For general information on providing feedback to the operator, see MIL-STD 1472F [9].

G3. Operator awareness of ESS state can not be sustained passively. Active involvement is essential for operators to exercise their responsibilities and be able to respond to emergencies. Reducing active involvement may be detrimental to the operator's understanding of important information, may lead to longer response times in case of emergencies, or, in the long term, may lead to loss of relevant knowledge or skills.

G4. ESS functions that increase the demand for cognitive resources of the operator is an artefact of poor design. Expert operators in complex, dynamic systems have been observed to cope with a poorly designed ESS by using only a subset of the available functionality, especially during periods of high workload.

G6. An ESS can cause extreme workload levels by increasing workload when it is already high and decreasing workloads that are already low. AN ESS is often introduced to reduce workload. However, reduction of workload may not always be advantageous, for example, if workload is already low.

G7. When an ESS requires the operator to devote a significant amount of attention to adjusting or monitoring the ESS functioning, this removes the operator away from minute-to-minute operations, thereby taking the operator out of the loop. This can be especially dangerous if an abnormal situation occurs that needs to be remedied quickly.

G8. An interruption during high workload or at a critical moment can cause a delay in the operator's ability to respond to an ESS malfunction, leading to a potential failure. If the operator is attending to an ESS malfunction and is interrupted, the interruption depletes the operator's mental resources causing him to be less capable of averting the potential failure.

G10. Operator requirements can serve as a guide to whether the data are available at all times, accessible at the operators' discretion, or not at all if the operator does not need information.

Evaluation methods and measures

Design verification:

- Analysis and design methodology are compliant with MIL-HDBK-46855A (Human Engineering Program Process and Procedures) [26].
- Verification of the adequacy of system usability and utility (in terms of its design).

Operator performance:

- Objective measures of the adequacy of OMI ease of use and usefulness through usability testing.

Operator situation awareness:

- Subjective assessment of the adequacy of the operator's situation awareness of ESS functioning.
- Subjective and objective (e.g., performance, errors) assessment of the adequacy of the operator's understanding of the limitations of the ESS.
- Subjective assessment of the adequacy of the operator's situation awareness of task-relevant objects in the environment.

Operator workload:

- Subjective assessment of the adequacy of the operator's workload.

Relationship to other guidelines

7.1.1 Employ operator centered principles

8.2.4 Maximize operator situation awareness by increasing system transparency

8.3.1 Keep operators "in-the-loop"

7.1.3 Promote ESS robustness and resilience to operator error

1. The ESS shall be resistant to operator error while tolerating some reasonable level of "error" and response variability.

2. The ESS shall be able to monitor operator interactions and to warn of operator errors.

3. ESS functions shall be capable of being overridden by the operator in an emergency. ESS functioning shall not be difficult or time consuming to turn on or off.

4. Operators shall not be too reliant on ESS functioning to the extent that their skills are degraded by extended use of the ESS and that they can no longer safely recover from emergencies or operate the ESS manually if the ESS fails.

5. ESS shall not be able to veto operator actions leaving the operator without means to override or violate the rules that govern the ESS unless there is not enough time for the operator to make a decision.

6. ESS interactivity (i.e., navigation, functionality, features, information structure) shall be consistent within and between systems.

7. ESS status during system setup shall be transparent to the operator (e.g., system failure due to system setup or manual input of information).

8. Allocation of tasks shall be flexible and adaptable (e.g., a task allocated to an ESS or an operator can be adapted according to the context) and the operator shall always have authority over how the tasks are allocated.

9. The ESS shall make it clear whether the operator or the ESS is supposed to perform a particular task at a specific time.

10. The allocation of tasks related to decision/action to the ESS shall be under the authority of the operator, particularly under situations of greater uncertainty and risk.

11. To increase operator trust in the ESS, ESS performance shall be: reliable and predictable with minimal errors; robust (able to perform under a variety of circumstances); familiar (uses terms and procedures familiar to the operator); and, useful.

12. The ESS shall be available to the operator as needed.

13. The ESS shall not interfere with task performance.

14. The ESS shall provide accurate and reliable information.

Source

HFDS, MS1472F, DISA, Sheridan00, AHCI, Parasuraman97, DEFSTD25.

Discussion

G1. To make a system error resistant is to make it difficult for an operator to make an error. Simplicity in design and the provision of clear information are tools to improve error resistance. Electronic checklists also have the potential to improve error resistance by providing reminders of items that need to be completed. Error tolerance is the ability to mitigate the effects of human errors that are committed. Error tolerance can be improved by adding monitoring capabilities to the ESS. Acceptable levels of error and response variability enhance learning (of the operator).

G4. A balance is needed between the efficiency created by the ESS, and the need for the operator to be able to recover from emergencies and control the ESS manually in case the ESS fails.

G5. The resumption of manual control needs to be within the capacity of the operator, without relying on manual skills.

G6. There are many possible types of interaction, such as menu selection, direct manipulation, and form-filling. An example of inconsistent interaction would be having one ESS require filling in forms as the interaction method, whereas another ESS requires menu-driven interaction. However, in the case of repetitive movement using a single input device (e.g., track-ball), operator fatigue can be mitigated by using an alternative method of interaction (e.g., touch screen in addition to the track-ball).

G7. ESS failures are often due to setup error. Although the ESS itself could check some of the setup, independent error-checking equipment or procedures may be needed. The operator needs to be able to distinguish whether a failure occurred due to the ESS setup or due to an inaccuracy in the input information. A failure could have been caused by a malfunction of an algorithm or by the input of inaccurate data. ESS operations that are easily interpretable or understandable by the operator can facilitate the detection of improper operation and the diagnosis of malfunctions.

G8. Problems with an ESS can occur when ESS-generated options do not apply to a situation and the operator is restricted to the options provided by the ESS.

G10. High levels of ESS automation (i.e., the ESS initiates and performs the task) can be used for tasks involving relatively little uncertainty and risk. Since the decision as to whether or not a situation is one of greater uncertainty and risk will be made by the operator, allocation should always be under control of the operator.

G11. Trust in automation tends to be relatively stable. However, changes in trust may occur over time. Operator trust in automation can increase with reliable and predictable performance. Decreases in trust may occur as a result of some critical error or automation failure. It is more difficult for operators to regain trust in automation after a failure than to develop an initial trust. Higher trust in automation is not always better because automation errors may be overlooked due to complacency. Decreases in trust typically occur suddenly, but increases happen slowly and steadily. The consequences of an automation failure (e.g., the magnitude of an error) impact the decline in trust.

G13. An operator will be less likely to accept an automated system that interferes with their ability to perform tasks.

G14. When operators believe the system to be highly reliable, they place greater trust in it. However, there is a trade-off involved with a constant high level of automation reliability and predictability. Constant high levels of reliability and predictability may be more likely to promote complacency and may cause operators to monitor the system with less vigilance.

Evaluation methods and measures

Design verification:

- Analysis and design methodology are compliant with MIL-HDBK-46855A (Human Engineering Program Process and Procedures) [26].
- Verification of the adequacy of system usability and utility (in terms of its design).

Operator performance:

- Objective measures of the adequacy of OMI ease of use and usefulness through usability testing.

System Performance:

- Demonstration of the predictability of the system.

Operator performance:

- Periodic objective assessment of operator skill-fade (e.g., assess competence to perform task manually at recurrent training intervals).

Operator situation awareness:

- Subjective assessment of the adequacy of the operator's situation awareness of system functioning.
- Subjective and objective (e.g., performance errors) assessment of the adequacy of the operator's understanding of the limitations of the system.
- Subjective assessment of the adequacy of the operator's situation awareness of task-relevant objects in the environment.

Relationship to other guidelines

7.4 Provide system response and feedback

7.5 Support identification and management of ESS faults and failures

8.2.4 Maximize operator situation awareness by increasing system transparency

8.3.1 Keep operators "in-the-loop

7.1.4 Support operator monitoring of ESS functioning

1. Informative feedback shall be given in case of an ESS failure, such as the likely cause and/or location of the failure.

2. The ESS shall be designed so that operators are able to monitor the ESS and the functionality of its hardware and software, including the display of status and trend information, as needed.

3. ESS tasks shall be designed so that operators are involved in active control and monitoring rather than just passive monitors.

4. System designers shall allow adequate cognitive resources for monitoring of the ESS by ensuring that task load does not become excessive.

5. Operators shall not be required to perform purely monitoring tasks for longer than 20 minutes at a time.

6. Important events shall occur in the same location on a display in order to promote effective monitoring performance, including when operators must monitor multiple displays.

7. The ESS shall provide some type of indication the system is still being monitored by some automatic system.

8. Critical ESS functions shall be independently monitored by the operator. A critical function is a function that can cause system failure when a malfunction is not attended to immediately.

9. Operators shall be given an adequate understanding (mental model) of how the ESS works in order to monitor effectively.

10. Intermittent periods of task monitoring by the operator shall be used during extended periods of task automation to improve monitoring of the ESS.

11. The effects on vigilance due to the use of ESS shall be considered before automating tasks or functions.

12. The ESS shall behave predictably so that the operator knows the purpose of the ESS functioning and how the task will be affected by that functioning.

13. The ESS shall provide means to indicate to the operator that data are missing, incomplete, unreliable, or invalid or that the system is relying on backup data.

Source

HFDS, Parasuraman97, Sheridan00, Endsley99.

Discussion

G1. Different messages shall be given, depending on whether the error is due to the central system or whether the error is local.

G2. One way that this can be accomplished is by providing the operator with access to raw data that the ESS processes.

G3. Failures in ESS functioning may be easier to detect when operators are involved in both active control and monitoring, than when they are just passive monitors.

G4. Operators using ESS may experience higher levels of mental workload than manual controllers due to monitoring, diagnosis, and planning, with significant cognitive demand resulting from relatively “simple” vigilance tasks.

G5. Operators may become complacent in monitoring an ESS if they have other tasks to complete simultaneously. Such decrements in operator monitoring of an ESS have been observed to occur in the laboratory in as little as 20 minutes.

G6. Operators will be able to detect a particular event more easily if they know where that event will occur (i.e., spatial certainty). Spatial uncertainty has been shown to increase perceived workload and decrease performance efficiency. If operators do not know where on a display an event will occur then they must engage in visual scanning to look for the event.

G8. When a function is critical, combining the monitoring of that critical function with other, possibly less critical functions may lead to delays in response. When a critical function is independently monitored, an operator can respond to a malfunction very quickly (within one second). If an operator is attending to another task when there is a malfunction, there will be a delay in the operator’s response (several seconds). In this period of delayed response, the malfunction can cause the system to fail. For this reason, critical functions require constant attention. Critical ESS functions do assist in the completion of critical tasks; however, they do not assist in freeing the operator to attend to other tasks.

G9. Operators must possess accurate mental models of the ESS in order to monitor effectively, comprehend current situations, plan their actions, predict future system states, remember past instructions, and diagnose system failures. One way to establish adequate mental models is through training.

G10. Complacency is a major concern with the automation of tasks. If practicable (i.e., the operator is able to perform the task(s) manually), intermittent periods of manual control have been advocated as a means of minimizing complacency. Decrement of cognitive abilities such as situation awareness and the loss of manual skills may also occur, making transitions from automated to manual systems difficult. Because automation of tasks can decrease basic manual skills, these skills should be used and maintained, if practicable. Intermittent periods of manual control during which ESS functioning is suspended periodically can promote optimal operator performance, and allow better recovery from failure, regardless of the type of task that is automated.

G11. A vigilance decrement, that is, a continuously decreasing ability to maintain attention over time while monitoring, may occur with the automation of tasks. Vigilance decrements do not

occur because monitoring tasks are under-stimulating. Rather, they require a large amount of cognitive resources and are often frustrating. Vigilance decrements have been observed to occur for both expert and novice. How hard the operator must work in order to maintain vigilance can be determined by at least two factors. First, workload is affected by the ease with which relevant signals can be detected. Signals that have low salience are more difficult to detect than signals high in salience. Visual fatigue will also require more effort to be expended in order to detect a signal. Second, musculo-skeletal fatigue associated with maintaining a fixed posture will increase the workload needed to perform optimal monitoring.

G12. The predictability of ESS functioning allows the operator to know what to expect when the ESS is functioning correctly. This makes it easier for the operator to recognize when the ESS is not functioning.

Evaluation methods and measures

Operator performance:

- Objective assessment of the adequacy of operator's accurate and timely detection of ESS faults and failures.

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of system functioning.

Operator workload:

- Subjective assessment of the adequacy of operator mental and physical workload.

Operator fatigue:

- Subjective assessment of the adequacy of operator fatigue.

Operator trust:

- Subjective assessment of the adequacy of operator trust.

Relationship to other guidelines

7.1.1 Employ operator centered principles

7.4 Provide system response and feedback

8.2.4 Maximize operator situation awareness by increasing system transparency

24.23 Train to overcome automation biases

7.2 Employ operator-centered OMI design

1. The ESS and associated integrated information displays shall be intuitive, easy to understand, and easy to use.

2. The ESS shall be simple for the operators to learn.

3. Support the operator recognising objects, actions and options rather than relying on the operator's memory (recall).

4. The ESS interface shall represent the simplest design consistent with functions and tasks of the operator.

5. The ESS interface shall be consistent with the expectations and understandings of the operator and shall reflect an obvious logic based on operator task needs and capabilities.

6. Navigation aids (e.g., landmarks) shall make it easy for operators to know where they are in the data space.

7. The OMI layout shall be organized according to the human perceptual system to reduce the operator's workload (e.g., proximity, matching patterns, unity, continuity, balance principles).

8. Where possible, spatial representations of information shall be used instead of verbal or textual displays to reduce the amount of mental computation needed to perform tasks (particularly for spatial tasks).

9. Dynamic information (i.e., information that changes over time) shall be presented in real time and on demand to ensure accurate and timely decision-making.

10. The ESS shall be flexible enough to allow for different operator styles and responses without imposing new tasks on operators or affecting overall system performance.

Source

HFDS, Nielsen94, Hutchins99, Zachary97, MS1472F, AHCI, DEFSTD25.

Discussion

G2. Simplicity for the operator is achieved by attaining compatibility between the design and human perceptual, physical, cognitive, and dynamic motor responsiveness capabilities.

G3. Objects, actions, and options shall be visible to the operator at all times. The operator shall not have to remember information from one part of the dialogue to another. Instructions for use of the system shall be visible or easily retrievable whenever appropriate.

G5. Consistency can be obtained by presenting information in predictable locations and keeping elements of screens such as headers, fields, and labels consistent in appearance and relative location throughout a system or application.

G6. Navigational aids can be a visually or cognitively salient object whose location can be associated with the locations of other objects. Landmarks, for instance, help people form a mental model for an information space. Because people perceive other objects in relation to this point of reference, a landmark will organize a space when people are searching for information (navigation).

G7. By applying human perceptual and memory characteristics to interface design, the amount of work an operator must exert in order to understand the information being presented can be reduced and allow the operator to focus on important information.

Evaluation methods and measures

Design verification:

- Objective measures of the adequacy of OMI ease of use and usefulness.
- Subjective assessment of the adequacy of system usability and utility.

Operator acceptance:

- Subjective assessment of the adequacy of the operator's perceptions of system usability and utility.

Relationship to other guidelines

7.1.1 Employ operator centered principles

7.2 Employ operator-centered OMI design

23.1 Adopt operator-centered design principles

7.3 Support different modes of operation

1. Modes shall be used in a complex ESS to partition the possible operator actions so that not all tasks/actions are available at the same time. Modes shall be used where the operator is likely to remain in a system mode for a period of at least some minutes.

2. When control, display, or automation functions change in different modes of ESS operation, mode and function identification and status shall be clear and distinct to the operator by providing feedback and clear status indicators (e.g., sound effects or visual indication).

3. Seldom-used ESS modes and functions shall be clearly identified. As an ESS becomes more complex with many modes and functions, the cognitive burden caused by the need for mode awareness increases. Seldom-used ESS modes and functions will pose the largest burden on the operator because of a lack of familiarity. Enabling the operator to immediately recognize the purpose of ESS modes and functions can lessen this burden.

4. Frequently used ESS modes shall be more accessible than infrequently used ESS modes.

5. The number of different modes for a given ESS shall be minimized.

6. The operator shall be able to easily switch between ESS modes.

7. The ESS shall alert the operator to the implications of interactions between modes, especially when they are potentially hazardous.

8. The ESS shall either prevent the use of potentially unsafe modes or alert the operator that a particular mode may be hazardous.

Source

HFDS, Nielsen94, MS1472F, DEFSTD25.

Discussion

G1. Modes can be a frequent source of operator error because operators often mistake the current mode, often from a lack of effective feedback on the state of the ESS (including which mode is active). For example, a flight management system might include modes relating to the cruise and descent phases of the flight. In this case, the same cockpit controls are used to manipulate different flight variables (e.g., speed versus descent rate) according to which mode the pilot has selected. If it is not clear to the pilot which mode the automation is in; potentially dangerous flight parameters could be inputted inadvertently into the system.

G2. Related systems shall have identical coding strategies, identical access and execution of system commands, consistent data display formatting, and consistent monitoring and reporting of resources.

G5. Multiple modes will provide a means of flexibility but will introduce more opportunities for error. Furthermore, a system that has multiple modes of operation can be difficult to learn and can produce increases in workload.

Evaluation methods and measures

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of system functioning in particular mode status (i.e., mode awareness).

Operator workload:

- Subjective assessment of the adequacy of operator workload.

7.4 Provide system response and feedback

1. The ESS shall continuously inform the operator about what it is doing, the purpose for doing so and how it is interpreting the operator's input. For every operator action, there shall be some feedback from the ESS. For frequent and minor actions, the response can be modest while for infrequent and major actions, the response shall be more substantial.

2. Feedback messages shall be phrased in a clear and precise manner and the use of abbreviations, and reference system shall be avoided.

3. The ESS shall provide a positive feedback to the operator regarding the acceptance or rejection of a data entry. When fixed-function key activation does not result in an immediately observable response from the ESS, the operator shall be given an indication of ESS acknowledgment.

4. The ESS shall keep the operator aware on a continuing basis of the function (or malfunction) of each automated sub-system and the results of that function (or malfunction). It is important to keep the operator "in-the-loop" (i.e., provide sufficient transparency of the system for the operator to maintain adequate awareness of the system's functioning).

5. The ESS shall alert the operator when a problem or situation is beyond its capability.

6. The ESS shall alert the operator to any new/important developments occurring in the processing and predicting of outcomes and models.

7. Response times shall be as fast as possible. Normally, no special feedback is necessary during delays of more than .01 second but less than 1.0 second. For delays between 2 and 10 seconds, a "busy" indicator shall be given to indicate how much computer processing has been done. For delays longer than 10 seconds, percent-done progress feedback is to be given to indicate when the computer expects to be done (e.g., percent-done indicator).

Source

HFDS, DEFSTD25, Parasuraman99, MS1472F, DISA, Endsley96.

Discussion

When feedback is poor, ESS functioning is considered to be silent. Silent automation may result in coordination and system failures. Operators may be surprised by the behaviour of silent automation.

Evaluation methods and measures

Design verification:

- Subjective assessment of the adequacy of system feedback.

Operator performance:

- Objective assessment of the adequacy of the operator's accurate and timely detection of ESS faults and failures.

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of ESS functioning.

Relationship to other guidelines

7.1.4 Support operator monitoring of ESS functioning

8.2.4 Maximize operator situation awareness by increasing system transparency

7.5 Support identification and management of ESS faults and failures

1. Make ESS failures apparent by making failure unambiguously obvious to the operator.
2. Provide adequate early warning notification of pending ESS failure or performance decrements to allow the operator to adjust to the new task load and take manual control.
3. Inform the operator of potential ESS failure and malfunctions.
4. The first alarm event shall be clearly identifiable so that the operator is able to identify the first event in case of a series of alarm events.
5. Provide sufficient diagnostic information that is self-explanatory and in plain English.
6. Error-prone conditions shall be minimized by maintaining operator awareness, providing adequate training, and developing standard operating procedures.

Source

HFDS, DEFSTD25, MS1472F, Parasuraman97.

Discussion

G1. Stress, preoccupation, and distraction may reduce the operator's ability to detect faults.

G2. In situations where ESS failure would require operator intervention, it is useful for the operator to be warned that he or she will need to take manual control before the ESS fails. Ideally, this warning needs to come in adequate time to allow the operator to adjust to the new task load. There may, however, be cases where it is not possible to provide advance notification of pending failure or where the estimate of time needed for the operator to take control is unknown.

G3. It can increase workload for the operator to continually monitor the ESS for failure. Advance knowledge about potential failures can also help the operator prepare to take manual control.

G4. In order for the operator to diagnose the ESS, diagnostics information needs to be self-explanatory and in plain language. The diagnostic information must provide the operator with the information they need without requiring the operator to seek additional references, or a help function, to understand the problem and the recommended solution.

G5. Errors may arise from data entry errors, monitoring failures, system workarounds, and mode misapplication. Error-prone conditions in an ESS may result from lack of mode awareness, lack of situation awareness, lack of systems awareness, increased heads down time, over-dependence on automation, and interrupted crew coordination. Automation-related errors usually occur in conjunction with other factors such as haste, inattention, fatigue, or distraction.

Evaluation methods and measures

Design verification:

- Verification that system provides clear and timely notification of pending ESS failures.
- Verification that a suitable training program and standard operating procedures exists.

Operator performance:

- Objective assessment of the adequacy of the operator's accurate and timely detection of ESS faults and failures.
- Objective assessment of the adequacy of the operator's accurate and timely management of ESS faults and failures.
- Objective assessment of the adequacy of the operator's ability (e.g., speed and error) to resume manual control.

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of ESS functioning.
- Objective assessment of the adequacy of the operator's ability to anticipate future ESS failures.

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Operator trust:

- Subjective assessment of the adequacy of operator trust in the ESS functioning.

Relationship to other guidelines

7.1.3 Promote ESS robustness and resilience to operator error

8 Class-specific ESS guidelines

8.1 Information management aids

8.1.1 Optimize information presentation and information management

1. Information presented to the operator shall accurately reflect system and environment status in a manner so that the operator rapidly recognizes, easily understands, and easily projects system outcomes in relation to system and operator goals.

2. Data changes that occur following an Information Management Aid display update shall be temporarily highlighted.

3. Reduce amount of information the operator must evaluate.

4. The Information Management Aid shall provide both information about an object's features and explanatory descriptions which support various decision making processes. For example, a track's features determining its intent and capability (i.e., its "threatiness") shall be displayed and/or easily accessible.

5. The Information Management Aid shall be able to effectively evaluate, integrate, and present information to the operator so that an accurate synthesized picture of the situation is achieved.

6. Information presented by the Information Management Aid shall be clear, meaningful, consistent, legible, discriminable, and structured and based on an understanding of the tasks performed by operators.

7. Information shall be unambiguous and meaningful to the operator.

8. When information must be updated quickly, the most important information shall be cued to ensure it will be the first to be processed by the operator. It is important that the cues shall be correct, as there may be significant costs of invalid cueing.

9. Incoming messages shall be queued automatically by the Information Management Aid so they do not disrupt current information handling tasks.

10. Long lists of information, tasks, and so on, shall be stored and prioritized by the ESS to minimize the number of decision alternatives and reduce the visual processing load of human operators.

11. Information Management Aid information shall be automatically reorganized into integrated or non-integrated arrangements depending on the current system status.

12. The Information Management Aid shall provide accurate and reliable information.

13. The Information Management Aid shall automatically notify the operator of meaningful patterns or events such as when it predicts a future problem.

14. The Information Management Aid shall present information at the level of detail that is appropriate to the immediate task, with no more information than is essential.

15. The Information Management Aid shall avoid repeating information that is already available.

16. The Information Management Aid shall be fully integrated and consistent with the rest of the OMI.

Source

HFDS, DISA, DEFSTD25, Hutchins99, AHCI.

Discussion

G1. Communication will be improved by allowing information to be presented in the most understandable format. Eliminating the need to translate information into a specific format will reduce workload.

G2. A primary objective of information automation is to maintain and enhance situation awareness. However, too much information presented simultaneously may become cluttered and make visual search difficult, interfering with status, decision-making, or control. It is important for the operator to be able to easily locate needed information. The operator's ability to detect a signal while monitoring varies inversely with the rate at which neutral background events are repeated. There is also good evidence that the ability to accurately define an event as a signal is improved if the operator has a good understanding of what a non-signal is.

G7. Where information coding techniques are used, the meaning associated with codes shall be, as far as possible, based on associations with which the target population can be expected to be familiar (such as "Red = Danger"). Words, names, and abbreviations shall be based on language and terminology used by the target operator population. Data parameters and units shall use formats which are meaningful to the target operators and consistent with the overall task context.

G11. Integrated information arrangement allows the operator to assess the overall status of the system. Integrating display components into aggregated arrangements may reduce the attention demands of fault detection. Non-integrated arrangement of components draws operator attention to system errors or other relevant information (i.e., "pop-out").

G12. Accurate and reliable information will increase the operator's trust in the system, support the decision making process, and increase the likelihood of an appropriate course of action.

Evaluation methods and measures

Design verification:

- Verification of compliance with guidelines concerning the presentation of information.

System Performance:

- Percentage of data objects correctly identified and prioritized.
- Percentage of misses and false positives.

- Age of information.

Operator performance:

- Objective assessment of the adequacy of the operator's accurate and timely detection and management of key events.

Operator situation awareness:

- Subjective assessment of the adequacy of the operator's situation awareness of task-relevant objects in the environment.

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Relationship to other guidelines

7.1.1 Employ operator centered principles

17.3 Data display

21 Maps and situation display

8.1.2 Optimize display of information

1. Event data shall be combined with a map background when the geographic location of changing events needs to be shown. This might be implemented as an operator-selectable function to avoid unnecessary levels of clutter.

2. Integrated displays shall combine various Information Management Aid information elements into a single representation.

3. Dynamic data that must be monitored by the operator shall be displayed as a graphic format.

4. Automated (i.e., ESS instigated) and non-automated (i.e., operator instigated) cues shall be made equally prominent to enable operators to collect confirming/disconfirming evidence before deciding on appropriate action.

5. Provide operators with displays (e.g., representational aids) that allow them to see directly the information they require rather than infer it from using more cognitively intense levels of data processing.

6. Display elements shall only be integrated if it will enhance status interpretation, decision-making, situation awareness, or other aspects of task performance.

7. Visual representations of data shall be used to (1) present huge amounts of data, (2) show emergent properties of large amounts of data, and (3) separate multiple dimensions within a single representation.

8. Graphical displays of information shall be used to reduce the amount of mental processing by allowing operators to spend less time searching for information.

9. Visual representations of information shall be used to represent data relationships.

10. Provide meaningful patterns of information by matching the operator's expertise in the domain (skills and knowledge of the domain).

Source

HFDS, Hutchins99, DEFSTD25, Zachary97.

Discussion

G5. Integrated information arrangement allows the operator to assess the overall status of the system. Integrating display components into aggregated arrangements may reduce the attention demands of fault detection. Non-integrated arrangement of components draws operator attention to system errors or other relevant information (i.e., "pop-out"). Presenting the information in a format relevant to the state of the system can facilitate the ability of the operator to quickly and easily assess the system status.

G7. A large amount of data (e.g., parametric) could be portrayed graphically for rapid assimilation by the operator. For instance, the operator could see, at a glance, a synthesized picture of the track's behaviour. Compared with more complex logical operations, this rather simple perceptual operation allows operators to omit steps that are otherwise necessary when a task is performed without a visual representation.

G8. The graphical presentation of information allows operators to substitute less demanding perceptual operations for more complex logical operations. That is, graphical displays allow decision makers to "see" directly the information they require rather than infer it. For example, determining a change in altitude (and the degree of change) can be immediately apparent when the operator glances at a line graph depicting a track's history. Meanwhile, graphics can help operators save time when searching for needed information when several related dimensions of information are encoded in a single graphical object. Novel graphical displays must be evaluated carefully to ensure that the operator interprets the graphical information in the way intended by the designer.

G9. The Information Management Aid can visually represent (1) system relationships, its rule network, and reasoning process; (2) visual associations between related information; and (3) new relationships previously seen as unrelated.

Evaluation methods and measures

Design verification:

- Verification of compliance with relevant guidelines concerning the presentation of information.

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of task-relevant objects in the environment.

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Relationship to other guidelines

17.3 Data display

8.2 Decision making aids

8.2.1 Ensure appropriate implementation

1. Decision making aids shall be used: for managing system complexity; for assisting operators in coping with information overload, for focusing the operator's attention; for assisting the operator in accomplishing time-consuming activities more quickly; when limited data results in uncertainty; for overcoming human limitations that are associated with uncertainty, the emotional components of decision-making, finite-memory capacity, and systematic and cognitive biases; and, for assisting the operator in allocating resources, managing detailed information, performing computations, and selecting and deciding among alternatives.

2. The decision making aid shall not be implemented when solutions are obvious; when one alternative clearly dominates all other options; when there is insufficient time to act upon a decision; when the operator is not authorized to make decisions; or for cognitive tasks in which humans excel, including generalization and adapting to novel situations.

3. The decision making aid shall assist, rather than replace, human decision makers by providing data for making judgments rather than commands that the operator must execute.

4. The operator shall be able to configure the decision making aid to provide the kind and level of support he/she requires.

Source

HFDS, Hutchins99, ACHI, Zachary97, DISA, Parasuraman97.

Discussion

G1. The objective of a decision making aid is to increase the speed of analysis of tactical data and allow for a more accurate course of action and decision timeliness and agility.

G3. Research has shown that experienced decision makers recognize the situation or scenario based on comparison of the features of the current situation with stored memory representations. Once the situation is recognized, solutions or course of action are stimulated by activation of these memory representations.

G4. Operators shall be able to determine when and how the decision making aid should be used.

Evaluation methods and measures

Operator decision making quality:

- Subjective assessment of the adequacy of the quality of the operator's situation assessment processes.
- Objective assessment of the adequacy of the timeliness and agility of operator decision making.
- Objective assessment of the adequacy of the consistency of operator decision making.
- Subjective assessment of the adequacy of the justifiability and rationality of operator decision making.

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Operator trust:

- Subjective assessment of the adequacy of operator trust.

Relationship to other guidelines

8.2.2 Support decision making strategies

8.2.2 Support decision making strategies

1. The decision making aid shall support decision alternatives.

2. When more than one alternative is available, the decision making aid shall provide alternatives in a recommended prioritization scheme based on mission and task analysis.

3. When the information used by a decision making aid is derived or processed, the data from which it is derived shall be either visible or accessible for verification.

4. The decision making aid shall be capable of planning a strategy to address a problem or guide a complex process.

5. Develop models of decision making strategies specific to the domain and the mission. From the decision making model, the type of information to display and how to display it will become evident.

6. The decision making aid shall keep the number of response options to a manageable number.

7. The support provided by the decision making aid shall be consistent with operator cognitive strategies and expectations (mental models).

8. The decision making aid shall be able to predict future data based on historical data and current conditions.

9. The decision making aid shall minimize queries by the operators for information.

10. The decision making aid shall be tailored to the expertise and skill of the decision maker and the support for one level of expertise shall not interfere with the support for operators with different levels of expertise.

Source

HFDS, Hutchins99, ACHI, Zachary97, DISA, Parasuraman97.

Discussion

G1. Arguments leading to system results and alternative solutions shall be displayed so that the operator is able to comprehend and evaluate computer-generated proposals and formulate a well-informed decision.

G3. Data that are not critical for an operation can be made available only upon request.

G4. Ensure that the decision making aid guides the operator through the process, providing automated guidance on how to define and analyze a problem and formulate a decision.

G6. The number of options that the operator must consider is expected to decrease when a decision making aid is used. Reducing the response options focuses the operator's attention onto the most viable options. However, presenting too few options might promote "cognitive tunnel vision", which should be avoided.

G7. A mental model is an individual's understanding of the processes underlying system operation.

G10. For instance, novices to the domain may rely on a rule-based interface (i.e., analytical) to aid in their decision process while experts may be more responsive to mental imaging techniques (e.g., Recognition-Primed Decision or feature matching). Novices typically have good knowledge of the domain (i.e., C2 processes) but it is composed largely of facts and basis concepts. Decision making strategies generally involve analyzing multiple variables and applying general, domain-independent problem solving methods (e.g., trial and error). As the operator becomes more adept, the consolidated knowledge and problem solving approaches support the use of seemingly more recognition/case-based approaches. Such an operator has developed a complex set of integrated declarative (the "what") and procedural (the "how to") knowledge both about the domain and

about the decision tasks to be performed in the domain. This rich mental model of the domain allows the operator to apply elaborated domain-based solutions. The decision making aid shall be designed to support the expert decision maker to recognize the case into which a specific decision situation fits. The expert decision maker can then retrieve the appropriate solution strategy and directly apply it with little or no intermediate analysis or reasoning.

Evaluation methods and measures

Operator decision making quality:

- Subjective assessment of the adequacy of the quality of the operator's situation assessment processes.
- Objective assessment of the adequacy of the timeliness and agility of operator decision making.
- Objective assessment of the adequacy of the consistency of operator decision making.
- Subjective assessment of the adequacy of the justifiability and rationality of operator decision making.

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of the reasoning behind recommendations from the decision making aid (i.e., system transparency).

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Operator trust:

- Subjective assessment of the adequacy of operator trust in the decision aid.

Relationship to other guidelines

8.2.1 Ensure appropriate implementation

8.2.3 Keep operators in control

1. Operators shall be able to determine when and how the decision making aid shall be used.

2. The decision making aid shall not be able to veto operator actions leaving the operator without means to override or violate rules that govern the decision making aid unless there is not enough time for the operator to make a decision.

3. The operator shall be able to initiate (i.e., over-ride) the automation of tasks even when a task has been designated to be decision making aid-initiated.

4. The decision making aid shall assist, rather than replace, human decision makers by providing data for making judgments rather than commands that the operator must execute.

5. The decision making aid shall allow the operator to receive direct assistance in planning how to carry out the intended task.

6. The decision making aid shall accept direction from the operators on which problem solving strategy to employ when alternative strategies are available.

7. Automated tasks or functions shall not be able to jeopardize safety or make a difficult situation worse.

8. When an operator might need to operate in out-of-tolerance conditions, then a deliberate overriding action shall be possible.

Source

HFDS, DEFSTD25, MS1472F, Parasuraman97, Sheridan00.

Discussion

G1. Operator acceptance of a decision making aid centres on whether the operator feels in control of the system.

G8. There may be cases, particularly in an emergency situation, when the operator needs to operate in out-of-tolerance conditions.

Evaluation methods and measures

Design verification:

- Verification that the system provides necessary information and tools to support decision making.

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of task-relevant objects in the environment.

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Operator trust:

- Subjective assessment of the adequacy of operator trust in the decision aid.

Relationship to other guidelines

7.5 Support identification and management of ESS faults and failures

8.3.1 Keep operators “in-the-loop

8.2.4 Maximize operator situation awareness by increasing system transparency

1. Processed data shall be accessible.

2. Promote knowledge about the intent of the decision making aid to the operator.

3. The decision making aid shall estimate and indicate the certainty of analysis and provide the rationale for the estimate.

4. The decision making aid shall give the operator access to procedural information used by the aid.

5. When the decision making aid provides explanations to the operator, it shall supply a short explanation initially, with the ability to make available more detail at the operator's request, including access to process information or an explanation for the rules, knowledge-basis, and solutions used by the decision aid.

6. When the decision making aid provides explanations to the operator, the explanation shall use terms familiar to the operator and maintain consistency with the immediate task.

7. The decision making aid shall alert the operator to changes in the status of important system information such as when critical information becomes available during decision aid utilization.

Source

HFDS, Zachary97, Hutchins97, DEFSTD25, Endsley96.

Discussion

G1. Where displays contain potentially large amounts of information, consideration shall be given to providing operators with facilities to manage the amount and types of information displayed at any one time. This can be achieved by applying filters and artificial intelligence (e.g., algorithms) based on the operator's role to help process the data.

G2. Monitoring of the decision making aid by the operator and the operator by the system can only be effective if each knows what the other one is trying to accomplish (i.e., intent). This might be achieved by displaying the current goals of the decision making operator (as well as progress made towards those goals).

G3. Research pertaining to the representation of system certainty (or uncertainty) to the operator is immature. Any attempt to represent system certainty (or uncertainty) to the operator must be thoroughly evaluated.

G4. Procedural information is information about the rules or algorithms used by the decision making aid. Knowledge of procedural information fosters operator acceptance of the aid because the operator is able to understand how the aid functions. As the operator becomes more familiar with a given situation, he or she requires less procedural information.

G5. Process information is the information about how the decision making aid accomplishes a task. This information is required by operators to decide whether to use the aid in unfamiliar situations and for identifying the nature and extent of malfunctions.

G7. Critical information in this standard refers to information that may have a significant impact on task completion.

Evaluation methods and measures

Operator situation awareness:

- Subjective assessment of the adequacy of the quality of operator situation assessment processes.
- Subjective assessment of the adequacy of operator situation awareness of task-relevant objects in the environment.
- Subjective assessment of the adequacy of the operator situation awareness of the reasoning behind recommendations from the decision making aid (i.e., system transparency).

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Operator trust:

- Subjective assessment of the adequacy of operator trust.

Relationship to other guidelines

7.1.4 Support operator monitoring of ESS functioning

7.4 Provide system response and feedback

8.3 Control and action aids

8.3.1 Keep operators “in-the-loop”

1. When tasks are automated, the tasks shall be easily understood by operators and matched to the operator’s mental model of the task.

2. A Control and Action Aid shall provide the operator with an appropriate range of control options that are flexible enough to accommodate the full range of operating conditions for which it was certified.

3. To promote sufficient levels of operator situation awareness of a Control and Action Aid, the operator shall be given immediate feedback to command and control orders.

4. Override and backup control alternatives shall be available for automated tasks that are critical to the integrity of the system or when lives depend on the system.

5. The operator shall be able to initiate and control the direction and pace of the tasks and/or functions of a Control and Action Aid until the point at which operator goals have been met.

6. Information for backup or override capability shall be readily accessible.

7. The Control and Action Aid shall be designed so that operators are involved in active control and monitoring rather than just passive monitors.

8. Allow reversal of operator actions (e.g., “undo” or “cancel” function) and give clear indications how reversal can be achieved.

Source

HFDS, Sheridan00, MS1472F, DEFSTD25, Endsley99.

Discussion

G2. Highly flexible Control and Action Aids can be useful when the operator knows how to implement the various options across a wide spectrum of operational situations. However, the multiple options that are associated with highly flexible systems also require additional cognitive resources in order for the operator to remember which mode is active.

G7. An active role will decrease the likelihood of complacency and lower vigilance and may increase situation awareness.

G8. In order to facilitate the operator’s perception of being in control (as opposed to the perception of the Control and Action Aid being in control of the operator), the Control and Action Aid shall allow the operator an easy exit out of as many interactions as possible. For example, by providing a cancel button, and undo and redo operations.

Evaluation methods and measures

Operator situation awareness:

- Subjective assessment of the adequacy of operator situation awareness of the reasoning behind the actions of the Control and Action Aid (i.e., system transparency).

Operator workload:

- Subjective assessment of the adequacy of operator workload.

Operator trust:

- Subjective assessment of the adequacy of operator trust.

Relationship to other guidelines

7.1.4 Support operator monitoring of ESS functioning

7.4 Provide system response and feedback

8.2.4 Maximize operator situation awareness by increasing system transparency

9 Input devices

9.1 Input device selection

1. Two main input devices shall be provided, the keyboard and a pointing device.
2. The keyboard shall be an extended COTS design.
3. The appropriate pointing device shall be determined for the application.
4. If a mouse or trackball is provided then these shall be chosen to be suitable for the Maritime environment.
5. Keyboards and input devices shall be in accordance with good ergonomic design principles.

Source

TBM, MSWUE, UCA.

Discussion

Input devices for a Maritime CCS include, at minimum, a keyboard and a pointing device. The pointing device used most often is a trackball and associated keys. The use of a trackball or mouse does not preclude the use of hard keys for specific functions. Voice activated controls are not suitable at this time for Maritime C2 functions.

Touch screen controls are suitable for infrequent operator tasks (such as setting up a system) but are not sufficiently developed at this time to be suitable control devices for ongoing Maritime C2 functions.

9.2 Interchangeability between input devices

1. The pointing device shall be the primary means of user-computer interaction.
2. The keyboard shall be available for performing operations, primarily as a backup or for shortcuts.
3. Navigation within and between the OMI windows, object selection, and other keyboard manipulations shall be consistent with the Microsoft windows style guide.

Source

TBM, DISA, MSWUE.

Discussion

Two main input devices shall be provided, a keyboard and a pointing device. Operators shall be able to use the keyboard and the pointing device interchangeably. For most operations, it is expected that the keyboard will be used primarily as a backup so that users can continue to operate a system if the pointing device fails. Accordingly, new hardware designs should be developed that permit the keyboard to be stowed in an easily accessible compartment, thus leaving the work surface free when the keyboard is not in use.

G2. The statement that the keyboard may also be used primarily for shortcuts was added to the original statement of this provision.

9.3 The pointer

9.3.1 General pointer requirements

1. The following basic physical operations shall be supported with the pointing device:
    - Press
    - Drag
    - Release
    - Click
    - Double Click
2. Double-click capabilities shall be accessible by either single-click or by press and-release operations.
3. A separate, explicit, action, distinct from cursor position, shall be required for the actual entry (e.g., enabling, actuation) of a designated position.
4. The home position for the cursor shall be consistent across similar types of displays.
5. If the display includes a tactical picture, the home position for the cursor shall be at Ownship.
6. When fine positioning accuracy is required, as in some forms of graphic and image processing applications, the displayed cursor shall include an appropriate point designation feature (such as crosshairs).
7. The pointer shall have a distinctive visual attribute that does not obscure other displayed entities.
8. The pointing device shall be associated with a single pointer on the screen.
9. The hotspot of the pointer shall indicate the precise location where operations occur.
10. The pointer shall move anywhere on the screen.

11. When users move the pointing device, the pointer shall move in the corresponding direction.

12. The pointing device-to-pointer movement ratio shall be close to 1:1 for most user interactions.

13. The pointer shall remain in place until moved by users; it shall not be moved by an application.

14. The pointer shall deviate less than .05 inch in any direction; .01 inch for high stability.

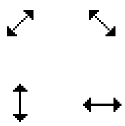
15. When a system uses multiple physical displays, the pointer shall move between multiple displays when users move the pointing device.

16. When a system uses only one physical display, the pointer shall not move beyond the physical display boundary or disappear from sight.

17. The location of the hotspot shall not move as the pointer changes shape. See Table 1 (below) for a list of functions for which shapes are defined in the MSWUE guidelines.

Table 2: Functions with Defined Pointer Shapes

	Pointing	The upper-left-pointing arrow is typically the pointer used in window areas for object selection. The hotspot is the arrow point.
	Moving	The four-directional arrow pointer indicates a move operation in progress. The hotspot is the point where the arrows intersect.
	Selecting text	The I-beam pointer is used in text areas to position the text insertion cursor and perform actions on text (e.g., selecting text). The hotspot is on the vertical bar of the I-beam one-third from the top.
	Processing an operation	The hourglass pointer indicates that an operation is being performed in a window area. When this pointer is displayed, all actions initiated by either the pointing device or keyboard is ignored in the area.
	Processing in the background	The hourglass-arrow pointer denotes that the system is processing an action in the background. The user is still able to perform other functions in spite of this processing. The hotspot is the arrow point.
	Context-sensitive help mode	The question mark-arrow pointer indicates that the user is in a context-sensitive help mode (e.g., invoked when

		a user selects the "What's This" button on the upper right corner of a secondary window). The hotspot is the arrow point.
	Zoom-in and zoom-out	The zoom-in pointer indicates the ability to "zoom-in" in order to see the object in more detail. The zoom-out pointer performs the reverse action.
	Resizing edges in specific orientations (vertically, horizontally, etc.)	The resize pointers indicate the directions for resizing an area. The horizontal and vertical resize pointers indicate resize in either the horizontal or vertical direction. The diagonal resize pointers indicate simultaneous resize in both the horizontal and vertical directions. The appropriate resize pointer appears when the pointer is placed on a frame boarder or size grip.
	Resizing a column	The column resize pointer denotes the ability to increase or decrease the width of a column. This pointer appears when the pointer is positioned on a column's vertical border or when vertically splitting a window.
	Resizing a row	The row resize pointer indicates the ability to increase or decrease the height of a row. This pointer appears when the pointer is positioned on a row's horizontal border.
	Not available as a drop target	The caution pointer appears when a user attempts to drop an object in a non-valid area.
	Navigate to linked reference	The hand pointer with the index finger extended appears when the cursor is placed over a hyperlink thereby indicating its function. The hotspot is the end of the index finger.
	Panning	The hand pointer with all the fingers extended denotes that the user is in the panning mode. Pressing the primary mouse button causes the fingers to "curl" as in a grabbing motion.

18. When the system identifies individual users (via a login process, for example), then the cursor controls shall be set by the user. If individual users are not identified then the cursor sensitivity shall be fixed and be compatible with the required task and user skills.

19. If the cursor is moved by pressing a key, releasing the key shall cause the cursor to stop moving.

Source

TBM, DISA, MS1472F, MSWUE, UCA.

Discussion

G3. Most entry-level computer users find it difficult to double click. Accordingly, double clicking shall be considered a short-cut tool for mid-level to advanced users.

G5. Ownship is the home position in the current Halifax-Class CCS.

9.3.2 Pointer shapes

1. The pointer shapes defined in MSWUE shall be used when providing the functions identified in Table 4.1: Functions with Defined Pointer Shapes.

2. The applications shall redefine pointer shapes only when the pointer is in an application window.

3. An upper-left-pointing arrow shall be used for object selection in most windows.

4. An X pointer shape shall not be used by an application.

5. New pointer shapes shall not be created for functions that already have a shape.

6. The MSWUE shall be the primary reference for pointer shapes, followed by shapes defined in TBM.

7. New pointer shapes shall follow the details of designs and technical guidelines available in MSWUE (Chapter 14).

8. Pointer shapes shall not be associated with functions they were not designed to represent.

9. New pointer shapes shall be easy to see, with a hotspot that is obvious and easy to locate.

10. New pointer shapes shall suggest their purpose and shall not be confusable with other objects.

Source

TBM, DISA, MSWUE, UCA.

9.3.3 Pointing device buttons

1. The Select (S) function shall be bound to the left button on a two- or three-button pointing device. This button will be referred to as the S button throughout the remainder of this document.

2. The Transfer (T) function shall be bound to the middle button on a three-button pointing device. This button will be referred to as the T button throughout the remainder of this document.

3. The middle button on a three-button pointing device shall be reserved for advance features and shall duplicate features accessible by the S button.

4. The Menu (M) function shall be bound to the right button on a three-button pointing device. This button will be referred to as the M button throughout the remainder of this document.

5. The Transfer function shall be bound to the right button on a two-button pointing device.

6. Chording (pressing multiple pointing device buttons simultaneously) shall not be used.

7. Left-handed users shall be permitted to exchange the functions between the left and right buttons.

8. The S button shall be considered the primary button. The secondary mouse button (by default the right button on a two-button pointing device) shall duplicate functions already accessible by the primary button.

Source

TBM, DISA, MSWUE.

Discussion

Only advanced users use the middle button on a three-button device. Many users do not use the secondary button on a two-button input device. Many users have difficulty using a double-click function. C2 operations require focused attention to C2 functions. Unnecessarily complex control actions (such as the above) should be avoided so that the crewmembers can focus their attention on the operations rather than on the OMI itself.

G6. MSWUE permits chording to be used only for advanced features.

Evaluation methods and measures

Design verification:

- Verification of the adequacy of input tools for the operational environment and consistent use of pointers to support the accurate and timely access to the functions.

Operator performance:

- Objective measures of the ease of use and usefulness of the input devices and pointers.

Operator acceptance:

- Subjective assessment of the operator’s perceptions of the ease of use and usefulness of the input devices and pointers.

10 Windows

10.1 Overview

The following three types of windows are addressed here:

- System (or root) windows
- Primary windows
- Secondary windows

The system window is a window that covers the entire display on which all other windows are displayed. Only one system window is allowed. On multi-monitor systems, each display contains a copy of the system window. The operators will not have access to the system functions through the INCOMMANDS OMI. System maintainers will need access to the system through another channel such as a separate terminal.

Primary windows provide the screen area under which most applications run. Secondary windows are called from primary windows to display information to or obtain information from the user.

Secondary windows can operate in modeless or modal modes. The most common types of secondary windows are dialog boxes (message windows), and menu windows. Secondary windows are always displayed in a consistent location or in a location within the proximity of the information to which it relates on the display.

10.2 System windows

10.2.1 Status bar

1. The window frame shall contain a status bar.

2. Display of classification is not required for CCS operations.

3. The classification level shall be displayed in the middle of the status bar, if the project office requires the display of classification.

4. A digital clock shall be displayed to the right end of the status bar, showing the Date/Time Group.

5. An alert (and messages) indicator (to notify the operator that alerts are present) is displayed on the left end of the status bar.

6. The notification of an alert shall indicate the priority of the alert, if available.

7. The contents of an alert (and message) shall be displayed in an area dedicated for that purpose near and below the alert notification indicator.

8. System alerts shall be identified distinctly from operational alerts in the alert notification area.

9. The status bar shall not be obscured.

10. The status bar shall contain an area to display the operator position(s) selected by the user upon login.

11. The operator position(s) currently in use that are displayed on the status bar shall not be colour-coded (to ensure they will not be misinterpreted as a security classification code).

Source

TBM, DISA, UCA.

Discussion

The source documents to this style guide call for a classification bar in the system window. The INCOMMANDS OMI style for the classification bar is different and the name of the bar has been changed to Status Bar. The status bar is addressed in this section. Classification bars require valuable real estate and add to the visual clutter of the display, without adding operational value. Accordingly, it is recommended that the classification information be optional for Canadian Maritime systems. Throughout this section the source citations have been retained but the term "classification bar" has been changed to "status bar".

G2. Operators report being aware of the classification status of the information in the CCS without having the classification status displayed on the monitor.

G10. If the project does not require the classification to be displayed, then the operator position(s) currently in use can be displayed in the centre of the status bar.

G11. The operational requirement to display the operator positions that are currently occupied should be validated with user testing. The requirement to display all of the occupied positions such as the Sensor Weapons Controller (SWC), Assistant Sensor Weapons Controller (ASWC), or Operations Room Officer (ORO) positions may be particularly useful if, for training purposes, more than one operator can occupy the same operational position.

10.2.2 Optional Display of Classification

1. The Title Bar and Window Border of classified windows shall be colour coded to display classification status. A window showing detailed classification information shall be available upon selection of the classification status.

2. When displayed data are classified for security purposes, a prominent indication of security classification level shall be labelled in each display.

3. The classification status shall be presented in the status bar. A secondary classification bar shall be located directly above the bottom border and shall span the entire width of the application area.

4. All words identifying the classification status shall be centred, in all capital letters, and at least 14-point bold font.

5. If space is at a premium, the secondary classification bar may be omitted. If more space is required, the classification bar may be omitted and the title bar and window border shall be used to portray classification status.

6. For a fixed window that does not contain a title bar, the border shall remain colour coded to display classification status.

7. When tabular data are divided into classifications, the classification titles shall be displayed and sub-classifications shall be identified. When tabular data extend over more than one page vertically, the columns shall be titled identically on each page.

8. The root window provides the highest level of classification of any open or minimized window.

9. When classified windows are open or minimized, the root window shall have its title bar and window border colour coded and may have classification bar(s) if space permits. This ensures that even if a window is hidden or minimized, the root window will let the operator know the highest security level of any open or minimized windows. The root window title bar shall not be covered by any other windows.

10. The Unclassified bar shall be displayed in green, the Confidential shall be displayed in blue, the Secret shall be displayed in red, and the Top Secret shall be displayed in orange.

11. The classification colours shall be displayed as the background of the classification text in the classification bar.

Source

CSFAB, TBM, DISA, MS1472F.

Discussion

G1. CSFAB also requires that the title bar and window border of unclassified windows shall not be colour coded.

G5. The option to omit the classification bars and place the classification status on the title bar has been removed due to the inclusion of the INCOMMANDS status bar in the styles.

10.3 Primary windows

10.3.1 Primary window characteristics

1. A primary window shall contain the following elements: Title Bar, Window Menu, Window Menu button, Minimize Control, Maximize/Restore Control, and Resize Borders.

2. The left side of the title bar shall contain navigation tools with a window menu button as the minimum navigation tool.

3. The name of the application shall be left justified next to the window menu button icon.

4. The right side shall contain manipulation tools with minimize, maximize, and close buttons as the minimum manipulation tools.

5. A fixed window is a special case of a primary window. A fixed window may contain a title bar but this is not a requirement if space is limited and the purpose of the fixed window is clear. It shall not contain minimize, maximize, or close buttons, or resize borders.

6. When multiple modes of operation exist, a means shall be provided to remind the user of the current mode. Modal operations shall be avoided.

7. The content of the application area shall be grouped into functional sub-areas of like information. These sub-areas shall take advantage of standard window sizes if possible.

8. Each sub-area shall be separated from other sub-areas by spacing or a framing (lines, shadow, etc.) and shall be labelled unless it will be unambiguously understood by the operator.

9. Operational controls (e.g., Quick Action Buttons (QABS)) shall be treated as fixed windows and shall not be obscured or covered within the display.

Source

CSFAB, MS1472F, MSWUE, UCA.

Discussion

G5. The requirements for fixed windows have been edited to reduce the number of menus required. Fixed windows cannot be closed and so should not have a close button.

10.3.2 Application primary windows

1. The application primary window shall be the first window displayed when an application is launched.

2. When an application primary window is minimized, all of its secondary task windows or dialog boxes shall also be minimized.

3. The application primary window shall be the only window that can close the application.

4. An application primary window shall contain the following elements: Window Menu Control, Title Bar, Title, Minimize Control, Maximize Control, Menu Bar, Resize Borders, and as an option, Standard Menus.

5. If the application primary window is the only primary window in an application, then the following standard menus shall be included in a menu bar: File, Edit, and Help. If the application primary window is used in conjunction with primary task windows, then an Application menu with the same name as the application and a Help menu shall be included in the application primary menu bar.

6. An application primary window shall follow the Microsoft window menu style.

Source

TBM, MSWUE.

Discussion

An application primary window is a specific case of a primary window. The application primary window provides application control. When an application consists of an application primary window only, the application primary window provides access to the application top-level tasks. If an application primary window is used in conjunction with several primary task windows, the application primary window provides application control and management of primary task windows.

10.3.3 Primary task window

1. The primary task window provides primary working areas for data display and manipulation of top-level tasks.

2. A primary task window shall be used to display primary data and controls for a top-level task.

3. A primary task window shall be closed or minimized independently from other primary task windows and the application primary window.

4. When a primary task window is minimized, all of its secondary task windows or dialog boxes shall also be minimized. When a primary task window is minimized processing in the window shall continue.

5. When a primary task window is closed, processing in it shall stop.

6. A primary task window may be closed but the application shall not be shut down via a primary task window.

7. A primary task window shall contain the following elements: Window Menu Control, Title Bar, Title, Minimize Control, Maximize/Restore Control, Menu Bar, and Resize Borders.

8. A primary task window shall have a standard Microsoft window menu.

Source

CSFAB, TBM, MSWUE.

Discussion

G7. This guideline has been edited to remove the requirement to include standard menus (e.g., File, Edit, and Help). Standard menus should be implemented if supported.

10.3.4 Fixed windows

10.3.4.1 Fixed windows characteristics

1. Fixed windows shall be fully visible to the operator at all times. Fixed windows are windows that are vital to the operation of the system and must be rapidly time-shared by the operator.

2. Fixed windows shall be automatically loaded upon system initialization and cannot be closed or minimized.

3. Fixed windows cannot be re-sized or re-located by the operator.

4. All fixed windows shall be tiled but do not have to occupy the entire display area.

5. No window shall overlay a fixed window.

6. The title bar and sizing frame are removed from fixed windows since they cannot be closed, moved or sized.

Source

CSFAB, UCA.

Discussion

Fixed windows are special cases of primary windows and are necessary in Maritime combat systems. Fixed windows are used for vital information that must be available to the operators at all times. These windows cannot be closed and must not be obscured by other windows. An example of a fixed window is a CCS tactical display. Because these windows are special cases, they do not have the usual capabilities of application windows. For example, they shall not have controls that permit them to be sized, relocated, or closed.

10.3.4.2 Specific cases of fixed windows

1. The following shall be fixed windows:
   - Message area (Alert Display)
   - Main tactical display (e.g., contact location, tracks, and route planning)
   - Tactical display function access and viewing

- Primary track amplification
- Primary function access (e.g., map controls)

10.4 Secondary windows

1. The display, controls, and function of each type of secondary window implemented in the application shall be consistent with the Microsoft Windows styles (see MSWUE Chapter 9). Types of secondary windows include the following:

   - Dialog Windows

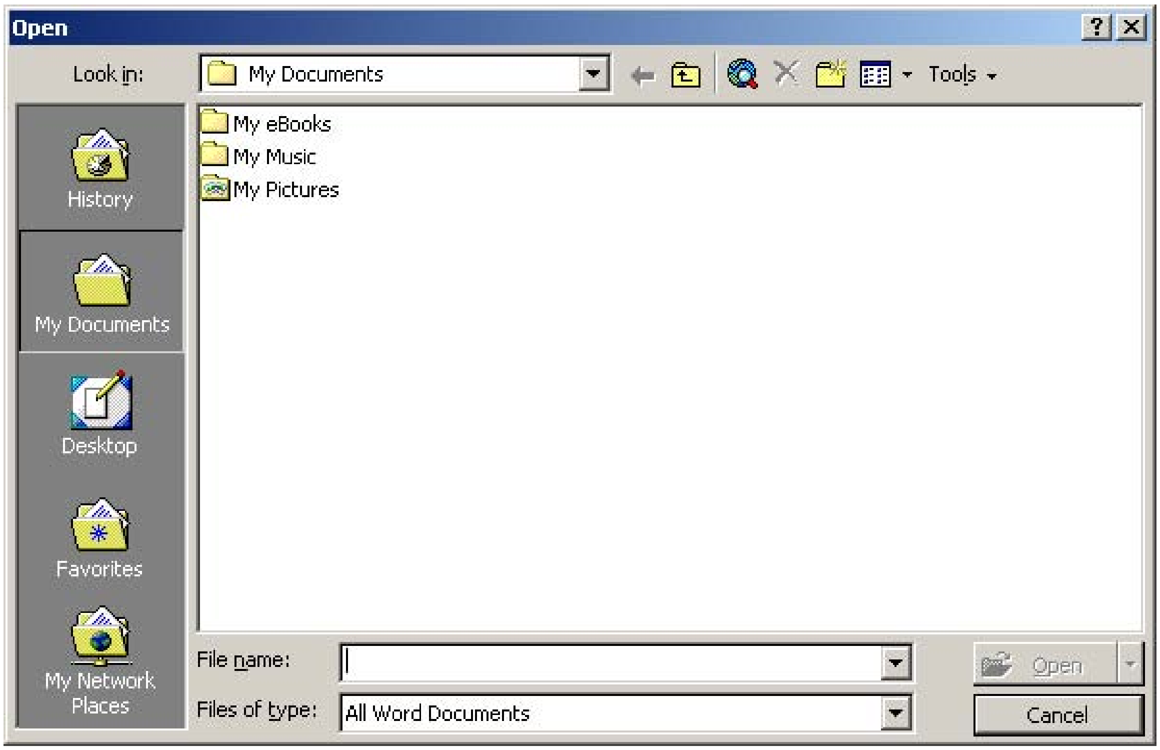


Figure 2: Example of a dialogue window

   - Prompt Windows
   - Message Windows
   - Error Message Windows

Figure 3: Example of an error message window

   - Information Message Windows

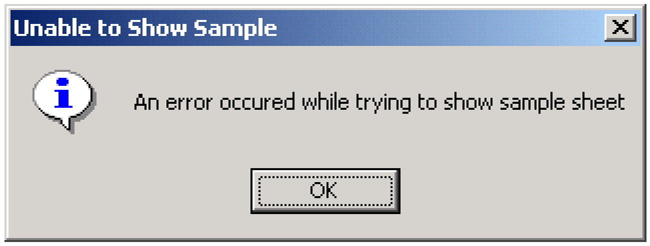


Figure 4: Example of an information message window.

- Question Message Windows

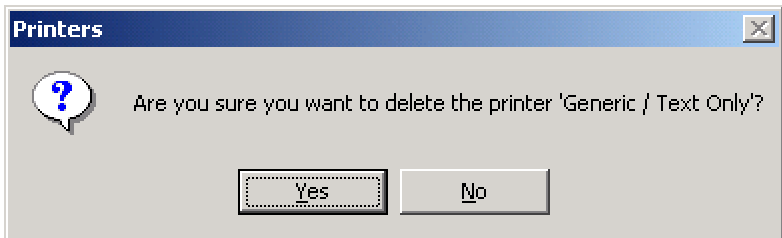


Figure 5: Example of a question message window.

- Warning Message Windows

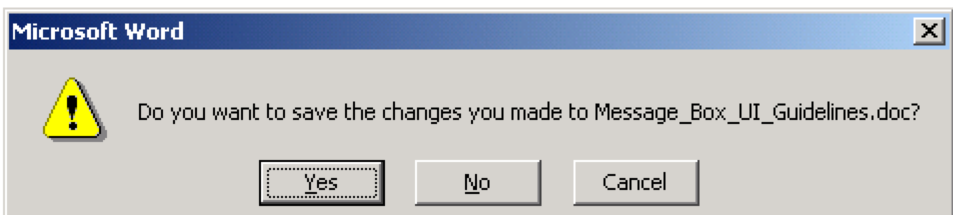


Figure 6: Example of a warning message window.

- Working Message Windows
- Selection Window

2. Secondary windows shall be used for short-term interaction with data and controls that support the primary task of a primary task window or an application primary window.

3. A secondary window shall contain a title bar. A secondary window shall contain resize borders and a maximize button if users are able to resize the window.

4. Secondary windows shall contain either a menu bar or an action area. An action area is more common and is provided when the number of possible user actions is five or less. A menu bar is provided only if the number of possible user actions is greater than five or if the user requires access to the File or Edit menus.

5. Message windows contain a message area and an action area. Users shall be able to move message windows but not close, minimize, or resize them. A message window may be modal or modeless depending on its purpose. The default action of all message windows shall be non-destructive.

6. The secondary window title bar shall contain navigation tools with a window menu button as the minimum navigation tool. The navigation tools shall be located on the left end of the title bar.

7. The name of the application shall be left justified to the end of the window menu button, followed by a colon and then the file name.

8. The right end of the window title bar shall contain manipulation tools with a close button as the minimum manipulation tool.

9. When a secondary window is opened, it shall appear in front of the parent window. The parent window shall stay displayed.

10. When a secondary window is closed, its children shall be closed but its parent shall not be affected.

11. A secondary window shall not shut down an application.

12. A secondary window shall not be opened at application start-up.

13. A secondary window shall contain the following: Window Menu Control, Title Bar, and Title.

14. The window menu for a secondary window shall only contain the following: Close and Move.

Source

CSFAB, TBM, MSWUE.

Evaluation methods and measures

Design verification:

- Verification that the windows conform to the guidelines in this section.

Relationship to other guidelines

11 Window design guidance

12 Windows navigation and selection

15 Windows states, components, and operations

11 Window design guidance

11.1 Consistency in design across windows

1. A consistent organizational scheme for key elements shall be used in all application windows.

2. The same window design shall be employed whenever users perform the same basic task.

3. Different or distinctive elements may appear in a window to fit the task being performed, but these elements shall be consistent across windows within an application.

4. Groups of windows with similar functions (e.g., a group of alert windows) shall be ordered by frequency of usage, with the most frequent at the top.

Source

TBM, MS1472F, UCA.

11.2 Arranging information to match user actions

1. A window shall be designed so users can manipulate objects in ways that support task performance.

2. Objects shall be arranged so users can move quickly and easily among them.

3. Pointer movement and keystrokes needed to perform a task shall be minimal.

4. Window layout shall support natural scanning order (from left to right and top to bottom).

5. Window layout shall be logical to users and appropriate to actions executed.

Source

TBM, DISA, MS1472F.

11.3 Arranging information by importance

1. The most important information and controls shall be in the upper left part of the window.

2. The objects in a window shall be arranged to accommodate the possibility that users may resize the window, if the window is resizable.

3. Task-critical information is visually set apart from other information in a window. At least one character line shall be left blank above and below critical information; at least two character spaces shall be left blank to the left and right of critical information.

Source

TBM, DISA, MS1472F.

11.4 Designing windows to minimize memory load

1. Users shall be able to perform the task called for in a window without referring to external information.

Source

TBM, MS1472F.

11.5 Window modality

1. Modal dialogs shall be used when the system must inform the user of a situation before proceeding (e.g., potential loss of data).

2. Modal dialogs shall be used when a task cannot proceed without additional information.

3. Dialog windows that are system modal shall appear as the top-most window.

4. Dialog windows that are full application modal shall appear as the top-most window when any window in the application that spawned that dialog window is selected.

5. Dialog windows that are primary application modal shall appear as the top-most window when the window that spawned the dialog window is selected.

6. Message dialogs shall be primary or full application modal.

7. If a modal window is used it shall contain all of the information necessary for the operator to make the decision.

8. When a dialog box is displayed it shall reflect the current state of the system. If a dialog box is modeless, then any changes to the application shall be updated in the dialog box.

Source

TBM, UCA.

Discussion

A window is either modal or modeless. There are three levels of modality as follows:

- Primary Application Modal. Primary application modal dialogs allow the user to interact with any other window on the display except for the window that is acting as the parent for the modal dialog window.
- Full Application Modal. Full application modal dialogs allow the user to interact with any window on the desktop except those that are a part of the same application as the modal window.
- System Modal. In the system modal dialogs the user is prevented from interacting with any other window on the display.

Modal dialogs shall only be used to help the user structure and keep track of a task and to prevent user errors.

11.6 Widget selection

1. Option buttons shall be used when selecting an option from up to six mutually exclusive options.

2. An option menu or combination box shall be used when more than six mutually exclusive options (no more than 10-12) are available.

3. Option menus are used to display small lists of mutually exclusive options. Option menus may be used in the place of a list or option buttons when only one list selection can be made and when space is limited. See MSWUE for the appearance and behaviour of option menus.

4. A list box shall be used when selecting from a large group of options (more than 12).

5. If the operator must select a numeric value then the following shall be used:
   - Scale or counter for continuous values within a range.
   - Standard Combination Box for a standard set of values normally selected and space is available.
   - Drop-Down Combination Box for a standard set of values normally selected and there is a need to conserve space.

6. If the operator must select a single option from a group of options the following shall be used:
   - Option button if there are six or fewer options and space is available.
   - Standard Combination Box if there are more than six options and space is available.
   - Drop-Down Combination Box to conserve space or to avoid clutter.

7. If the operator may select multiple options from a group of options the following shall be used:
   - Check box if seven or fewer options are available.
   - List if more than seven items are available.

8. If the operator must transfer or copy items from one group to another a Transfer List shall be provided.

9. Option buttons or an option menu shall be used when the set of options is not likely to change.

10. A list box shall be used when the options might change.

11. Push buttons shall be used for frequently used actions, and when the pointing device is already moving.

12. Pop-up menus shall be used only when it is critical to the application that users be able to access functions without moving the pointing device.

13. Pop-up menus shall not be used as the only method available for accessing operations.

14. Option menus shall be used when setting values or choosing from a set of related items.

15. Vertical scroll bars shall be provided if the list is longer than the viewable list box area. Horizontal scroll bars shall be avoided if possible. A horizontal scroll bar shall only be used if most items in a list are considerably shorter than a few longer items and screen space is limited.

Source

CSFAB, TBM.

Discussion

G7. CSFAB places the limit at six.

11.7 Coding critical information

1. Capitalization shall not be the sole indication of critical information in a window.

2. When special symbols are used to signal critical conditions, they shall only be used for that purpose.

3. Bolding/brightening, colour coding, etc., shall be used to focus attention on critical information.

4. Coding shall be employed to differentiate between items of information and to call the user's attention to changes in the state of the system. Coding shall be used for critical information, unusual values, changed items, items to be changed, high priority messages, special areas of the display, errors in entry, criticality of command entry, and contacts.

Consistent, meaningful codes shall be used. Coding shall not reduce legibility or increase transmission time.

5. Colour shall be used for alerts, and users shall be required to respond before an alert is terminated.

6. When a user's attention must be directed to a portion of a graphic display showing critical or abnormal data, that feature shall be highlighted with some distinctive means of data coding.

7. When a special symbol is used to mark a word, the symbol shall be separated from the beginning of the word by one space.

8. A maximum of two levels of intensity (brightness) shall be used. Brightness shall only be used as a code if the objects coded are adjacent. Each level shall be separated from the nearest other level by not less than a 2:1 ratio.

9. Users shall be alerted to critical information in an inactive or minimized window.

Source

CSFAB, TBM, DISA, MS1472F.

Discussion

G5. The requirement to use an audible alarm was removed from the above provision. See Section 18.1 for more information regarding audible alarms and alerts.

G8. Absolute brightness is difficult to interpret. Using brightness as a code should be avoided. Brightness refers to the intensity of a particular hue.

Evaluation methods and measures

Design verification:

- Verification that the design of windows and window elements supports the utility of the OMI.

Operator performance:

- Objective measures of the ease of use and usefulness of the windows and window elements.
- Assessment of the extent to which the design of the windows and window elements support the timely access to critical information and completion of critical tasks.

Operator acceptance:

- Subjective assessment of the operator's perceptions of the ease of use and usefulness of the windows and window elements.

Operator situation awareness:

- Subjective assessment of the perceptibility of critical information.

Relationship to other guidelines

10 Windows

12 Windows navigation and selection

15 Windows states, components, and operations

18.1: Audible alerts and flash coding

12 Windows navigation and selection

12.1 Window navigation

12.1.1 Window mode

1. In modeless windows, users shall be able to interact with other windows while the modeless window is displayed on the screen.

2. Modal windows are used when the operator must address the contents of the window before further processing can continue or to ensure the user has received an important message. Modal windows shall only be used when it is critical that the system obtain further information or that the user acknowledges certain information before anything else can begin.

3. Modal windows shall not restrict interaction with windows higher in the hierarchy unless it is critical that the system obtain further information or that the user acknowledges certain information before anything else can begin.

Source

CSFAB.

12.1.2 Input focus policy

1. Only one window on the screen shall have input focus at any time.

2. Users shall assign focus explicitly particularly if overlapping windows are implemented, and shall do so either with the pointing device or from the keyboard.

Source

TBM, DISA.

12.1.3 Assigning focus to a window with a pointing device and the keyboard

1. Users assign focus by moving the pointer into a window and clicking the Select (S) button.

2. If users click in an empty window area, the window frame shall highlight and the window shall be raised to the front.

3. If users click in the title bar, the frame shall highlight and the window shall be raised to the front and shall receive input focus.

4. If users click on an object within a window, the window frame shall highlight, the window shall be raised to the front, and an object shall be selected.

5. A window is raised by clicking anywhere in the window. The window is then moved to the top of the window hierarchy (except for any toolbars or pallets associated with the window being raised) and is given input focus. A window may also be raised by selecting it from the open window menu.

6. <Alt> + <Tab> and <Alt> + <Shift> + <Tab> shall move the focus forward and backward through window families (i.e., primary windows and window icons).

7. <Alt> + <F6> and <Alt> + <Shift> + <F6> move the focus forward and backward through windows in a family.

Source

CSFAB, TBM.

12.2 Navigation within windows

12.2.1 Pointing device navigation for controls

1. Placing the pointer on a control and clicking the S button shall move the location cursor to the object and shall give the object focus.

2. Pressing the <Ctrl> key and clicking the S button on an object shall select the object and keep the current object selected.

3. Autoscrolling shall be available when the pointer is on a scrollable control such as a text block or a list.

4. The means shall be provided to readily move the cursor to the head or the foot (end) of a file.

Source

TBM, MS1472F.

12.2.2 Keyboard navigation for controls

1. Cursor tab controls or other provisions for establishing and moving readily from field to field shall be provided for the purpose of editing programs or tabular data.

2. The <Ctrl> + <Tab> and <Ctrl> + <Shift> + <Tab> keys shall move the location cursor to the next and previous tab group, respectively.

3. The <Tab> and <Shift> + <Tab> shall move to the next and previous tab group except in the multi-line text widget.

4. The location cursor shall be on the default or first control (i.e., top left most) when it moves to a tab group.

5. The location cursor shall skip a tab group if none of the controls can have keyboard focus.

6. The Up, Down, Left, and Right arrow keys shall move the location cursor between controls in the tab group with focus.

7. Moving the location cursor to a control shall not change the state of the control.

8. The direction of cursor movement within a window shall be from upper left to lower right and shall wrap between the first and last tab groups in the window.

9. Arrow keys shall move the location cursor one increment at a time (e.g., to the next line in text, to the next item in a list); <Ctrl>+Arrow keys move the location cursor one large increment (e.g., move the text cursor to the next word instead of the next character).

10. The virtual <Home> and <End> keys shall move the cursor to the leftmost/rightmost element in a control.

11. <Ctrl> + <Home> and <Ctrl> + <End> shall move the cursor to the beginning/end element in a control.

12. The virtual keys <PageUp>, <PageDown>, <PageLeft> (or <Ctrl> + <PageUp>), and <PageRight> (or <Ctrl> + <PageDown>) shall scroll the elements in the control up, down, left, or right one page minus one unit of information (e.g., one line of text) at a time.

13. The title “Window” shall be in all application pull-down menu bars to allow for the selection of hidden windows. The <Alt> + <Tab> keyboard accelerator shall shuffle through all open windows in an application.

14. Keyboard focus shall remain on the element where it was before scrolling began even when the location cursor may not be in view.

15. When keyboard action alters the element with focus, scrolling shall occur so the element is in view.

Source

CSFAB, TBM, MS1472F.

12.2.3 Keyboard navigation for graphic objects

1. Navigation among graphics objects shall use the same key bindings as navigation among controls.

Source

TBM.

12.3 Object selection

12.3.1 Pointing device selection methods

1. Click the S button on an object to select it. When another object is selected, previously selected objects are deselected.

2. To select multiple objects, click the S button on objects one at a time while holding down the <Ctrl> key. The objects are highlighted and selected.

3. Where text has been specified to become the subject of control entries (e.g., for underlining, bolding, moving, copying, or deleting), the affected segment of text shall be highlighted to indicate its boundaries.

4. To select a range of contiguous objects, the pointer shall be positioned on the first object in the range to be selected, and then the S button shall be selected to set the anchor for the range. Any other object that was selected shall be deselected. The pointer shall be dragged until it is on the last object in the range, and the S button shall be released to complete the selection.

5. To extend a range selection the user shall position the pointer on the object that shall be the last one in the selection, and hold down the <Shift> key while clicking the S button on the pointing device. The objects in the revised selection range (defined from the original anchor to the current pointer position in one-dimensional collections, and defined by the diagonal from the anchor to the current pointer position in two dimensional collections) shall be reselected, and any elements removed from the selection shall return to normal appearance.

6. To add or remove a non-contiguous object to or from a range selection, the pointer shall be positioned on the object, and then the <Ctrl> key shall be held down while clicking the S button on the pointing device. If previously unselected, the object shall be selected and highlighted. If previously selected, the object is deselected and shall return to a normal appearance. The other elements in the selection shall remain highlighted.

7. A bounding box shall appear when dragging the pointer over elements in a two dimensional collection.

Source

TBM, MS1472F, MSWUE.

12.3.2 Keyboard selection methods

1. Add mode shall be used to select one element or multiple objects one at a time. Normal mode shall be used to select multiple contiguous objects.

2. The location cursor shall be a solid rectangle in normal mode and shall be a dotted rectangle in add mode.

3. Add mode and normal mode are used to select multiple non-contiguous objects.

4. <Space> (and the virtual key <Select>) shall select an object or multiple objects one at a time.

5. <Space> (and the virtual key <Select>) shall set the anchor for selecting a range of contiguous objects.

6. <Shift> + <Space> (and <Shift> + <Select>) shall extend selection from anchor to last object selected.

7. <Shift> + <F8> shall toggle between add mode and normal mode.

8. <Ctrl> + </> shall select all of the objects in a collection.

9. <Ctrl> + <\> shall deselect all of the objects in a collection.

10. Cancel shall undo a selection action and return the objects to their normal appearance.

Source

TBM.

Discussion

The keyboard and the pointing device shall be used to make selections. The normal mode and the add mode are used to make keyboard selections. The normal mode is used for making simple contiguous selections from the keyboard. The add mode is used for making more complex selections which may be disjoint. In normal mode, the location cursor and the highlight are on the same element and move together when the arrow keys are used. In add mode, the location cursor moves independently of the highlight.

12.3.3 Other types of selection

1. A default action in a window is executed by double clicking when making a selection.

2. Pressing <Enter> or <Ctrl> + <Return> shall invoke the default action after making a selection in a window.

3. The <Return> key shall invoke the default action in a window if the focus is on an object other than multi-line text.

4. Extended selection shall be available in text.

5. In a text widget a single click shall place the text cursor, a double click shall select a word, and a triple click shall select a line of text.

6. The virtual <Cancel> key shall cancel the action being executed and shall return the object to its state prior to action.

Source

TBM.

12.4 Object transfer

12.4.1 Object transfer overview

1. Individual objects or a collection of objects shall be able to be transferred in a window or to another window in the same application as well as into other applications. This shall be accomplished by two or more of the following four techniques:

- Clipboard transfer
- Primary transfer
- Quick transfer
- Drag transfer (drag and drop)

2. The transfer techniques to be implemented include at minimum clipboard transfer and drag transfer techniques.

3. For each transfer technique the following operations shall be generally available: Copy, Move, and Link.

Source

TBM, UCA.

12.4.2 Clipboard Transfers

1. When inserting characters, words or phrases (e.g., editing), items to be inserted shall be collected in a buffer area and displayed in the prescribed insert area of the screen for subsequent insertion by user command.

2. Clipboard transfer shall allow users to move and copy objects by transferring them first from their current location to a temporary clipboard and then from the clipboard to a new location. Clipboard transfer can be used, for example, to transfer text (e.g., strings of characters, blocks of text) and graphics (e.g., lines, shapes, entire figures) within or between windows or applications.

3. A clipboard move operation shall consist of cut and paste operations; a clipboard copy operation shall consist of copy and paste operations.

4. Clipboard transfer operations shall be available whenever an object that can be edited has keyboard focus. Applications shall provide access to these operations as menu options, push buttons in a window, or other buttons, and users shall be able to execute the operations either with the pointer or from the keyboard.

5. Access to clipboard transfers shall be implemented in a consistent fashion throughout the application. Access to clipboard transfer shall be available only when it is appropriate to the task being performed by users. Users shall be able to view the contents of the clipboard and shall be informed (e.g., in a message window) when they attempt to cut or copy an object whose size exceeds the capacity of the clipboard. The clipboard is only displayed at the request of the user.

6. The clipboard transfers operations of Cut, Copy, and Paste shall be performed using the Edit menu of an application.

7. Clipboard transfer shall be available whenever an editable object has keyboard focus.

8. A clipboard transfer operation shall be invoked from pull down or pop-up menus and have standard keyboard bindings. Access to clipboard transfer shall be provided in consistent fashion throughout an application.

9. Keyboard accelerators shall be available to perform other editing operations (e.g., Clear, Delete).

10. Users shall be capable of viewing the clipboard contents and shall be informed when they cut/copy an object of excessive size for the clipboard.

11. Cut operations shall be performed by the following: Selecting Cut, <Ctrl> + <X>, and <Shift> + <Delete>).

12. Cut shall clear the previous contents of the clipboard, store a copy of the source object in the clipboard, and remove the source object from the window.

13. If the cut object is a graphic, the space where the graphic object was previously located shall be left blank. If the cut object is text, the remaining text shall be compressed in the text widget.

14. Copy shall clear the previous contents of the clipboard and store a copy of the source object in the clipboard; the source object shall stay in its original location.

15. Copy operations shall be performed by the following: selecting Copy, <Ctrl> + <C>, <Ctrl> + <Insert>).

16. Paste shall duplicate the object in the clipboard to a new location.

17. Selecting Paste, <Ctrl> + <V> and <Shift> + <Insert>) shall perform a paste operation.

18. If the clipboard content is text, paste shall copy the clipboard contents to the location of text cursor and existing text appears to the left of cursor. If existing text is selected, paste shall copy the clipboard contents to the location of the selected text and remove the selected text. The pasted object shall remain in the clipboard until another object is cut/copied.

19. If the clipboard content is graphic, paste shall copy the clipboard contents to the pointer location in a window with input focus. The pasted object shall remain in the clipboard until another object is cut/copied into it.

20. A Copy Link entry in the Edit menu shall be used to place a link in the clipboard to selected elements of the target component so that the link can be placed in a destination by subsequent use of the Paste or Paste Link.

Source

CSFAB, TBM, MS1472F.

Discussion

The clipboard transfer technique transfers an object selection from a source to the clipboard and then from the clipboard to the destination.

12.4.3 Primary transfer

1. Primary transfer operations shall include primary copy, primary move, and primary link.

2. A primary transfer operation can be invoked from Pull Down or Pop-up Menus and have standard keyboard bindings. Access to primary transfer shall be provided in consistent fashion throughout an application.

3. Primary transfers shall also be invoked using the T button.

4. The default operation for primary transfer using the T button is copy.

5. In an editable collection, a Primary Copy is performed by the following: T button click, <Ctrl> + T button click, and <Alt> + <Ctrl> + <Insert>.

6. In an editable collection, a Primary Move is performed by the following: <Shift> + T button click and <Alt> + <Shift> + <Delete>.

7. In an editable collection, a Primary Link is performed by the following: <Ctrl> + <Shift> + T button click.

8. Editing commands (such as move, copy, and delete) shall be provided for adding, inserting, or deleting text/program segments.

Source

TBM, MS1472F.

Discussion

The primary transfer technique transfers the primary selection directly to a destination without using the clipboard for immediate storage of data.

12.4.4 Quick transfer

1. The quick transfer operations of quick copy, quick cut, and quick link are available.

2. Quick transfers shall be invoked using the <Alt> + T button.

3. The default operation for quick transfer using the T button is copy.

4. Text components must support quick transfer.

5. If quick transfer is supported, <Alt> + T button motion or <Alt> + <Ctrl> + T button motion must temporarily select elements in the specified range and, on release, must copy them to the insertion position of the destination component.

6. If quick transfer is supported, <Alt> + <Shift> + T button motion must temporarily select elements in the specified range and, on release, must move them to the insertion position of the destination component.

7. If quick transfer is supported, <Alt> + <Ctrl> + <Shift> + T button motion must temporarily select elements in the specified range and, on release, must place a link to them at the insertion position of the destination component.

Source

TBM.

Discussion

A quick transfer technique allows the user to indicate a range of objects (called a secondary selection) that are transferred to the destination component.

12.4.5 Drag transfer (drag and drop)

1. A drag and drop operations shall be executed by pressing the primary button while pointing to an object, moving the input device while holding the button down, and then releasing the button at the destination.

2. The default transfer operation shall be move.

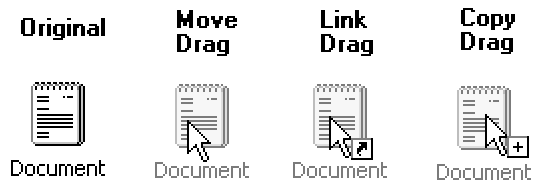


Figure 7: Drag transfer (drag and drop).

3. <Cancel>, or equivalent, shall cancel a drag operation and return the object being dragged to the original location.

4. Elements moved within a component shall remain selected after they have been moved.

5. Dragging a set of selected elements shall drag the entire collection.

6. Dragging in overlapping elements shall occur on the highest draggable element in the stack.

7. The pointer shape shall change to a drag icon during the drag operation and then back to pointer at the completion of the operation.

8. The drag icon shall contain a source indicator and may contain operations and state indicators.

9. When users must repeatedly move objects by means of a drag transfer action and the drag destination is to the same or a default location, redundant transfer methods shall be used. Redundant transfer methods shall include the capability to drag a set of selected objects or double-click on an object as a command accelerator for the drag action.

10. A drag move operation shall be executed by holding down <Shift> while dragging the object using the T button. If no modifier key is used (that is, just the T button is pressed on an object) the default operation is a move.

11. A drag copy operation shall be executed by holding down <Ctrl> while dragging the object using the T button.

Source

TBM, MSWUE.

Discussion

Movable or copyable text and objects shall be able to be moved or copied to a new location by using the pointer and the drag function.

G2. MSWUE describes variants of the drag and drop transfer operation. The variants include defining the transfer operations as copy or link or destination-specific commands such as print or send to. These variants add undue complexity to a CCS OMI and should not be used.

12.5 Interactive Control

12.5.1 Object-action selection

1. Users shall first select an object, and then they shall select an action to perform on that object.

12.5.2 User control of interaction

1. Applications shall execute an action only in response to explicit user input.

2. Users may take actions that will interrupt or terminate a process.

Source

TBM, DISA.

12.5.3 Immediate feedback

1. Control feedback responses to correct user input shall consist of changes in state or value of those display elements which are being controlled and shall be presented in an expected and logically natural form

2. When users take an action, there shall be an immediate and visible response to the action.

3. A visible response shall occur even if the result cannot be displayed immediately.

4. An application shall provide visual cues that indicate when it can accept input, when it is temporarily unavailable, and when it is unavailable during extended processing.

5. The appearance of an object shall indicate its availability.

6. If an operation requires several actions, users shall be prompted with the actions to take.

7. Applications shall ignore user actions made during periods when input cannot be accepted.

8. The pointing device and/or the keyboard shall be disabled when input may be destructive.

9. Although an application shall not allow users to override disabling, users shall be able to stop a process if desired (e.g., by selecting a cancel, or equivalent, push button).

10. The current value of any parameter or variable with which the user is interacting shall be displayed.

Source

TBM, DISA, MS1472F.

12.5.4 System response time

1. System response times shall be consistent with operational requirements.

2. Required user response times shall be compatible with required system response time.

3. Required user response times shall be within the limits imposed by the total user tasking expected in the operational environment.

4. The system shall give warning information when a command is invoked when that command will be time consuming or expensive to process.

5. System response shall be within .2 seconds of user action; display shall take no more than .5-10 seconds.

6. Requests for new displays may take between 2-10 seconds if an operation requires extensive processing. Timing shall begin from the time of a user action to the time that a fully populated display is presented.

7. Error feedback shall be provided to users within 2 seconds of the time error was detected.

8. When a user request takes more than 2 seconds to process, the pointer shape shall change to an hourglass.

9. When response to a user request takes 5-15 seconds to process, an animated cursor shall be presented to show progress.

10. When response to a user request will take 15 seconds to 1 minute to process, a message window shall be displayed immediately informing the user that processing is ongoing.

11. As a matter of operational necessity, all processing must be able to be interrupted by the users.

12. For delays exceeding 60 seconds, a countdown display shall show delay time remaining.

13. Where system overload or other system conditions will result in a processing delay, the system shall acknowledge the data entry and provide an indication of the delay to the user. If possible, the system shall advise the user of the time remaining for the process or of the fraction of the process completed.

14. Maximum system response times for real-time systems (e.g., fire control systems, command and control systems) shall not exceed the values presented in

Table 3 below.

Table 3: Response time definitions

System interpretation	Response time definition	Time (secs)
Key response	Key depression until positive response, e.g., "click"	.1
Key print	Key depression until appearance of character	.2
Page turn	End of request until first few lines are visible	1.0
Page scan	End of request until text begins to scroll	.5
XY entry	From selection of field until visual verification	.2
Function	From selection of command until response	2.0
Pointing	From input of point to display point	.2
Sketching	From input of point to display of line	.2
Local update	Change to image using local data base, e.g., new menu list from display buffer	.5
Host update	Change where data is at host in readily accessible form, e.g., a scale change of existing image	2.0
File update	Image update requires an access to a host file	10.0
Inquiry (simple)	From command until display of a commonly used message	2.0
Inquiry (complex)	Response message required seldom used calculations in graphic form	10.0
Error feedback	From entry of input until error message appears	2.0

17. During start-up, the system shall display a message window indicating its unavailability, change the pointer shape to an hourglass or watch, and disable input from the pointing device and keyboard.

18. When the system is ready, the message window shall disappear, the pointer shall return to a standard shape, and the input shall be enabled.

19. If appropriate, the system shall display status messages (e.g., response time and unavailability).

20. If computer processing time requires delay of concurrent user inputs, and no keyboard buffer is available, keyboard lockout shall occur until the computer can accept the next transaction. An alert shall be displayed to indicate to the user that lockout has occurred.

21. When the computer is ready to continue after a response-time induced keyboard lockout, a signal to so indicate shall be presented (e.g., the cursor changes back to normal shape).

22. When keyboard lockout has occurred, the user shall be provided with a capability to terminate a transaction that has resulted in an extended lockout. Such capability shall act like an undo command that stops ongoing processing and does not reset the computer thereby losing prior processing.

Source

TBM, DISA, MS1472F, UCA.

Discussion

The system should always keep users informed about what is going on by using appropriate feedback. The Microsoft Copy dialog box presented below (see Figure 8) illustrates how the system can provide feedback during a time-intensive function. Note that the progress bar and time indicate the expected length for executing the actions as well as the ability to cancel the operation. In addition, the dialog box can provide a simple animation to let the user know that the action is being carried out.

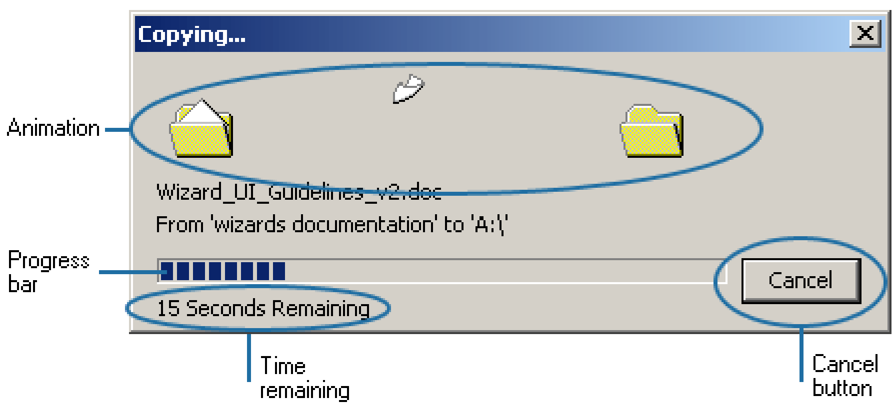


Figure 8: Example of system feedback.

G11: If an exemption to this guideline is necessary, and a process is included that cannot be interrupted by the user then the following guidance from TBM shall be followed: When response to a user request will exceed 1 minute and processing will prevent the user from further interaction until the process is complete then a confirmation shall be presented prior to the process being initiated. The confirmation message shall inform the user of the expected duration of the process and that the user will be unable to continue until the process is complete.

12.5.5 Error detection

1. The application shall not execute a user-requested action that is considered invalid. Instead, an error message shall be displayed.

2. A capability shall be provided to facilitate detection and correction of errors after keying in but before entering the information into the system. While errors shall be detected early, error checking shall occur at logical data entry breaks (e.g., at the end of data fields rather than character-by-character) in order to avoid disrupting the user.

3. User errors shall be minimized by use of software checks of user entries for validity of item, sequence of entry, completeness of entry, and range of value.

4. When users make multiple errors with a single action, they shall be notified of each error. Multiple occurrences of the same error shall not appear in separate windows.

5. When users make multiple errors with a single action, they will be provided with an immediate description of the error and the total number of additional errors detected, as in a word processing spell checker. There shall be some means for the user to request and correct sequential display of error messages.

6. To prompt for correction of an error in stacked commands, the system shall display the stacked sequence with the error highlighted. Where possible, a procedure shall be provided to correct the error and salvage the stack.

7. A computer-detected error, as well as the error message, shall be continuously displayed until the error is corrected.

8. When an error is repeated, feedback shall show that an attempted correction was processed.

9. Users shall be required to correct only an invalid action and not to repeat the entire sequence. The system shall permit correction of individual errors without requiring re-entry of correctly entered commands or data elements.

10. After making a correction users shall be able to execute the same action for re-entry that was used for the original entry.

11. Error messages shall first state the problem followed by a statement of appropriate solutions.

Source

TBM, MS1472F, UCA.

12.5.6 Undo capability

1. Users shall be allowed to undo the most recent selection or action unless the selection or action required explicit destruction.

2. Users shall be allowed to execute a multi-level undo.

3. In addition to being able to undo commands, users shall be able to deselect objects, return an object to its prior state before an action was executed, and retrieve information that was removed from the screen.

4. Users shall be allowed to re-do the most recent, or specified “undone” transaction.

5. Irreversible actions (actions that cannot be undone) shall be labelled and clearly separated from actions that are reversible.

6. If an action cannot be labelled as irreversible, the user shall be presented with a warning and asked to confirm the irreversible action.

7. When an undo option is provided, the wording shall change dynamically to reflect the action that can be undone. The undo option shall always begin with Undo. For example, if the most recently executed action is a cut, the undo option shall be worded Undo Cut.

Source

CSFAB, TBM, MS1472F, MSWUE.

Evaluation methods and measures

Design verification:

- Verification of ease and consistency of navigation of the interface.

Operator performance:

- Objective assessment of use and usefulness of tools for navigating through the OMI through usability testing.

Operator acceptance:

- Subjective assessment of the adequacy of the operator’s perceptions of usability, utility, and consistency of tools for navigating through the OMI and ESS.

Relationship to other guidelines

10 Windows

11 Window design guidance

15 Windows states, components, and operations

13 Controls

13.1 Control characteristics

1. All of the types of controls in a window shall be identifiable solely based on their appearance.

2. All controls with the same function shall have the same appearance.

3. Text/graphics in a window shall be clearly different in appearance from standard controls.

4. Controls performing similar or related functions shall be physically grouped together.

5. Grouped controls shall be framed and shall be clearly labelled to indicate the functions they perform.

6. Controls that are temporarily unavailable shall be dimmed and shall not be available for selection.

7. Controls that are never available to users shall not appear in a window.

8. Lines surrounding a group of controls shall follow the look and labelling of Microsoft Windows styles.

Source

CSFAB, TBM, DISA, UCA.

Discussion

G1. Generally all selectable objects have a three-dimensional appearance (i.e., appropriate shadowing) and all non-selectable or display-only objects are not three-dimensional in appearance.

13.2 Control actions

1. Control actions shall be minimized, consistent, make minimal memory demands of the user, and be sufficiently flexible to adapt to different user needs.

2. Very frequent or safety-critical tasks shall be identified and shall be accomplished with a single operator action such as a keystroke or button press.

3. Frequent or critical tasks shall be identified and shall be accomplished with no more than three operator actions (keystrokes, button presses, etc.)

4. User acceptance of stored data or defaults shall be possible by a single confirming keystroke.

5. Control actions to be selected from a discrete set of alternatives shall have those alternatives displayed prior to the time of selection.

6. User control inputs shall result in a positive feedback response displayed to indicate performance of requested actions.

7. If a default button is defined it shall be non-destructive. A destructive action is an action that cannot be reversed (e.g., missile launch), or cannot be routinely reversed without extensive or special procedures (e.g., un-erase a file), and therefore shall be preceded by a user confirmation in a dialog box. The confirmation shall usually be the “OK” button (or equivalent), unless the action is destructive wherein the “Cancel” button shall be used as the default. The default can only be used when the default button is active.

Source

CSFAB, MS1472F.

Discussion

G2. Examples of frequent or safety critical tasks for Halifax-Class CCS operations include hooking tracks or changing the range in the tactical display.

G7. The implication is that an action such as a missile launch requires a second, confirming action. In hardware implementations the second action is usually opening the trigger guard. The design of the confirming action must consider the entire operational task.

13.3 Control areas

1. The QABs (or their functional equivalent) shall be located on the same monitor as the tactical picture so as to reduce eye and hand movements.

2. The display shall include visual affordance for the operators.

3. Controls for operations that are potentially destructive shall not be co-located with frequently used or confusable controls.

4. Frequently used and critical controls shall be located at anchor points within the display or shall be organized in order of priority.

5. Controls shall have a large active area so that the operator does not have to access a small target area.

6. Direct access to the desired levels of controls shall be obtained without requiring intervening steps.

7. Controls shall be sufficiently large to be accessed easily under expected Maritime conditions.

Source

UCA.

Discussion

If the operator must search for a control then the operator's attention is devoted to the interface rather than the operational task. New layouts and designs should provide good visual affordance to improve navigation within the tactical controls. New controls should also address the sequence with which operators access the functions and should support the operational task flow.

13.4 Action icons

1. Action icons shall have unique graphic images so that users recognize the action performed. Action icons shall not conflict with action icons that are already defined.

2. Action icon graphics in an application shall be consistent with icons in other applications in the system and shall be consistent with the icons that are already defined.

3. Developers shall use a short text label in addition to a graphic for action icons. This is especially important if the function being represented is highly abstract.

4. Colours used in images in action icons shall be similar to other system colours and used in a consistent manner.

5. Graphics for action icons representing opposite actions shall be designed to mirror each other.

6. Graphics shall be presented in a common style and oriented consistently within the button.

7. An action icon shall be large enough for a user to see and understand the graphic and text label. An action icon shall also be large enough to be easily selectable via the pointing device.

8. Action icons shall be grouped by task relevance or frequency of use.

9. Action icons shall duplicate, but do not replace selections in a pull-down menu.

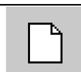
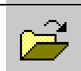
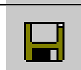
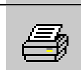
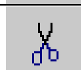
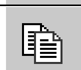
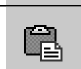
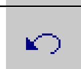
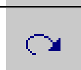
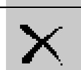
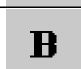
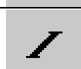
Source

TBM.

Discussion

Action icons provide unique graphic images that enable the user to recognize the action to be performed. Table 4 depicts some of the common action icons that exist across Microsoft applications.

Table 4: Examples of action icons.

Icon	Term	Action Performed
	New	Opens a new document within the application.
	Open	Launches the Open dialog box in order to open an existing document.
	Save	Saves the current document.
	Print	Prints the current document.
	Print Preview	Opens the preview window so that the print version of the document can be viewed on-line.
	Cut	Removes an object from a window and stores it on the clipboard
	Copy	Duplicates an object to the clipboard without deleting it from the window.
	Paste	Inserts an object from the clipboard into a window at the selected location.
	Undo	Returns an object to its state prior to the last operation being executed.
	Redo	Reverts the Undo operation.
	Delete	Deletes the selected object from the window.
	Bold	Bolds the selected text.
	Italics	Changes the selected text to italics.

G3. An ellipsis (. . .) is used to indicate that a push button or menu command will present a dialog box when selected. Since the space available for text labels on action icons is limited, the ellipsis may be eliminated for action icons only. Text labels may be omitted if action icons are presented in a palette as in drawing tools for graphics.

13.5 Push buttons

13.5.1 General push button characteristics

1. Push buttons shall be used to initiate an action.

2. Every window shall provide a push button (e.g., Close and Cancel) that allows users to dismiss the window.

Source

CSFAB, TBM.

13.5.2 Appearance

1. Push buttons shall be the same width within a grouping of vertical buttons. A group of buttons that are horizontally arranged do not require equal button width.

2. Push buttons shall be wide enough to display the longest button label or largest action icon.

3. Button width shall be made larger if window space is available.

4. Buttons that are used frequently shall be as large as possible.

5. Push button minimum size shall be as follows (measured inside the traversal highlight):

   - Text Size. Text size shall be sufficiently large that text is readable with a margin surrounding the text as indicated in MSWUE.
   - Icon Size. Icons shall be sufficiently large so that the icon can be identified and discriminated from other icons; at least 0.26 inches height and width.
   - Empty button: at least 0.20 inches in both height and width.
   - QAB size. A QAB button shall be sufficiently large for three lines of readable text (8-10 char. per line) or two lines of text plus a colour bar; at least 0.70 inches in both height and width.

6. All push buttons in an action area of a dialog window shall be the same size. An exception to this design rule may occur in order to accommodate a push button label or graphic that is significantly longer that the other push button labels in the window.

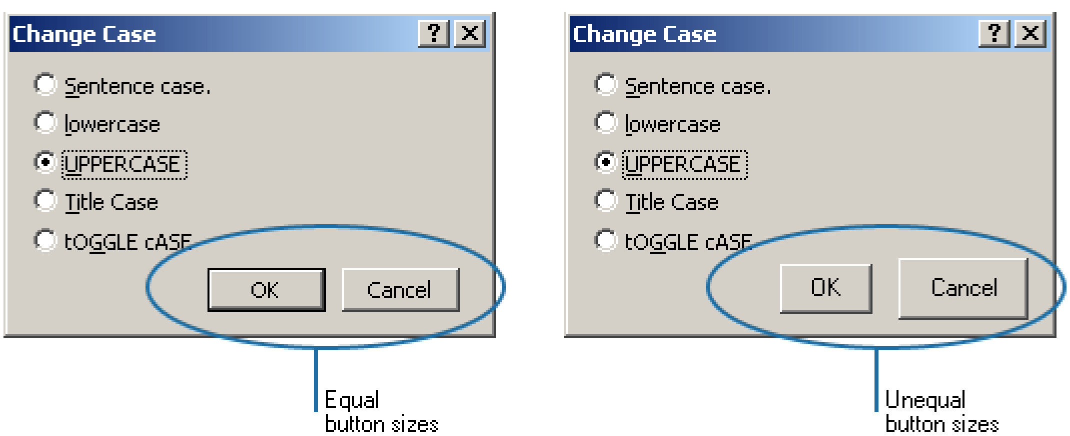


Figure 9: Example of Equal and Unequal Button Sizes.

7. The colour of the face of buttons shall be one colour when the button is pressed and a different colour, or shade, when the button is not pressed. The colour differences shall be sufficiently distinct to be easily discriminated by the operator and shall be consistent with the colour guidelines in this style guide.

Source

CSFAB, TBM, MSWUE, UCA.

Discussion

G5. See MSWUE (Chapter 14) for a detailed presentation of spacing and positioning of OMI interface items.)

G7. This guideline was added as a result of the review of the COMDAT TD.

13.5.3 Push button labels

1. Push button labels shall be large enough for easy reading at minimum over-the-shoulder viewing distances (i.e., 27 inches). There shall be enough space between the label and the rectangle surrounding it so that the label will not restrict the legibility or visibility of the text or the graphic in the push button.

2. Push button labels shall be short and unambiguous and the label shall be mixed case with the first letter of each word capitalized (book title capitalization).

3. If push button actions affect different objects, their labels shall reflect what each affects.

4. Action button labels shall describe the action, stated in active voice, taken by the application when the action button is selected (e.g., Print, Save, Delete).

5. The label for action buttons shall describe the results of pressing the button and reflect the action that will be taken by the application rather than the user.

6. When “All” is used in a push button label, there shall be no ambiguity as to reference.

7. Push button labels with multiple references shall include the name of the object/element. For example, a “Select All” button for map symbols is better labelled “Select All Symbols” to make the reference clear.

8. Existing vocabularies shall be used to construct push button labels whenever applications perform actions that are already defined elsewhere. Before creating a new vocabulary, it shall be determined at minimum if the vocabulary already exists in the following sources, (these sources are listed in order of precedence):

   - MSWUE
   - CSFAB
   - TBM

   Other references shall also be reviewed, with priority given to CCS style guides, to avoid creating duplicate vocabularies.

Examples of these vocabularies (drawn from TBM) include the following:

- Manipulating Primary Windows
  - Back
  - Close
  - Exit
- Manipulating Files and Directories
  - Delete
  - Save As
  - Print
- Editing Text or Graphics Objects
  - Cut
  - Paste
  - Find
- Manipulating Items
  - Delete
  - Edit
  - Sort
- Manipulating Maps
  - Pan
  - Zoom
  - Centre On

9. A new vocabulary shall be created as needed to describe actions not defined in the existing guidance documents.

10. When new vocabulary is used, it shall describe actions not listed in the guiding documents.

11. If a new action is created, it shall be a verb, stated in active voice, and shall describe the action that will occur upon selection of the button.

12. A more specific command label shall be substituted for Yes, No, and OK whenever possible (e.g., Save, Print).

13. OK and Yes shall not be the label for the default button if the action executed by the button is potentially destructive. The default push button shall have an extra border around it. The labels for accepting an action shall reflect the action to be taken.

14. The names of actions shall be congruent (e.g., save/delete, on/off, in/out).

15. The same vocabulary shall describe the same action throughout the application/system.

16. Existing icons shall be used whenever applications use icons that are already defined elsewhere. Before creating a new icon, it shall be determined at minimum if the icon already exists in the following references; these references are listed in order of precedence. Other references shall also be reviewed, with priority given to CCS style guides, to avoid creating multiple icons to convey the same meaning.
    - MSWUE
    - CSFAB
    - TBM
17. A push button shall have an ellipsis (. . .) if selecting it results in another window (other than a help window or a confirmation window) being displayed.

Source

CSFAB, TBM, MSWUE, UCA.

Discussion

G1. TBM indicates that the labels shall be large enough for easy reading at normal viewing distances. In Canadian Maritime operations, the CCS displays are often needed by crewmembers that are not seated at the display. Supporting over-the-shoulder reading distances benefits over-the-shoulder viewing and optimizes the visibility for the operator when in a relaxed posture.

G8. CSFAB, MSWUE and TBM each provide tables of existing vocabularies.

G9. TBM refers to specific tables.

G13. For example: “Launch Missile” is a better label than “Yes” or “OK”.

G16. CSFAB, MSWUE and TBM each provide tables of existing icons.

13.5.4 Push button organization

1. Buttons within sets shall be sub-grouped according to similar functions. A subgroup may contain one or more buttons.
2. A set of buttons that supports a specific task sequence shall be grouped from left to right and/or from top to bottom.
3. Push buttons shall be located near the object(s) they affect.
4. Push button order shall use the following common labels and actions and applicable buttons shall appear from left to right in the following sequence: Yes, No, OK, Close, Apply, Retry, Stop, Pause, Resume, Reset, Cancel.
5. A “Help” button shall not be required in every window. The button to access help shall be in accordance with Microsoft Window conventions (e.g., a “?” button to the left of the “Close” button.)
6. The order of push buttons in modal windows shall be: OK, Cancel.

7. The order of push buttons in modeless windows shall be: OK, Apply, Cancel or OK, Apply, Reset, Cancel.

8. Application-specific push buttons shall be ordered left to right based on the sequence of use, with the most often used push button on the left.

9. Buttons for positive actions shall be at the left, and followed by negative/destructive and cancelling actions.

10. Push buttons shall appear in the same order in windows throughout the application.

11. Push buttons related to overall window functionality (e.g., OK, Cancel) shall be located at the bottom of the window in a row that is centred horizontally across the window.

Source

CSFAB, TBM.

Discussion

G4. Yes, No, and OK should be replaced by more specific command labels whenever possible.

G11. Push buttons shall appear in the action area of a dialog.

13.5.5 Activating a push button

1. The S button on the pointing device shall be used to activate a push button.

2. The <Space> key (and <Select> if available) shall select a push button from the keyboard when the location cursor is on a push button.

3. When a push button is selected, it shall highlight and the action it represents shall be executed.

4. Push buttons shall be activated by single clicks of the pointing device only. A double click action shall not be used on a push button.

Source

TBM.

13.5.6 Default push buttons

1. A default push button may be available in dialog windows of an application. A default push button shall be indicated by an extra border around it (see MSWUE for design details).

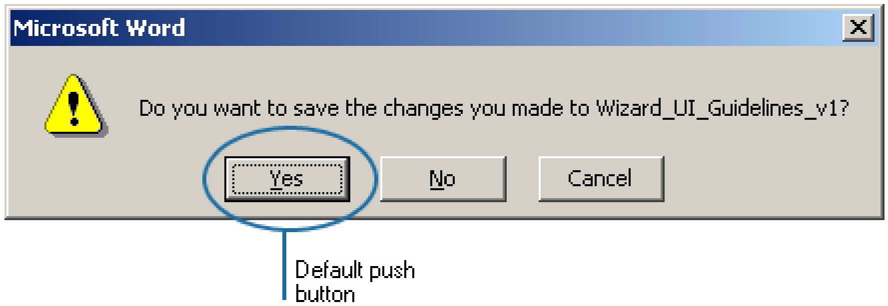


Figure 10: Example of the default push button on a MS warning message window.

2. The same push button shall be the default whenever a dialog window is initially displayed.

3. The default push button in a window may vary depending on the object with keyboard focus in a window.

4. Default designation shall move with the location cursor during keyboard navigation through push buttons.

5. Default designation shall return to the original button when focus leaves the push button group.

6. OK and Yes shall not be the default push buttons if the action executed by the button may be destructive.

7. Whenever possible, the default action shall be reversible.

8. Apply shall be the default action in modeless windows that are displayed for multiple actions.

Source

TBM, MSWUE, UCA.

13.6 Toolbars

Toolbars are on-screen menus that use icons instead of words to represent functions. Using icons instead of words allows many more options to be provided in the same display area. The fact that the toolbar is always present on-screen allows quick access to options.

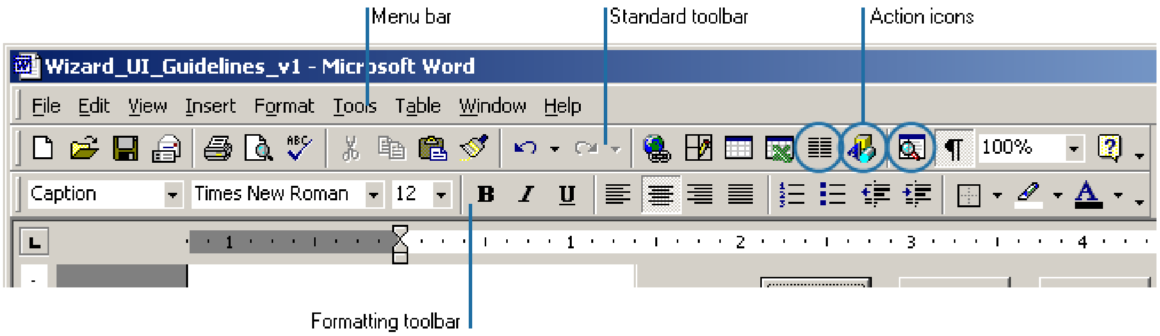


Figure 11: Example of docked toolbars. It illustrates the horizontal configuration for the Standard and Formatting toolbars that are typically docked at the top of the application window for Microsoft Word. To assist with their identification, labels for each action icon in the toolbars in Microsoft Word are presented via the ToolTips functionality.

Figure 12: Example of a Floating Toolbar. It illustrates a floating configuration for the Microsoft Standard toolbar presented above. In this example, the shape of the toolbar has been changed to align the buttons across two rows as opposed to one.

13.6.1 Toolbar general characteristics

1. Only commonly used options shall be placed in a toolbar.

2. Toolbars shall be placed directly below the menu bar or may be converted into their own window and placed at any allowable display location by the operator (see Figure 11 and 12).

3. Specific toolbars shall hold groups of options that are needed for a specific task (e.g., drawing tools) (see Figure 11).

4. Toolbars shall provide a redundant means of accessing a function (all functions in a toolbar shall also be available in the menus).

5. All the action icons in a palette or a toolbar shall be the same size (see Figure 11).

6. When an icon in the toolbar is pre-selected, the pull-down menu name of that command shall be displayed below the icon as a Tool Tip. This is a form of help that allows users to become familiar with the icons and shall be able to be disabled once the user becomes fully familiarized with the icons.

Source

CSFAB, TBM.

Discussion

G6. This concept is described in detail in MSWUE as Tool Tips. Design details and timing information are provided in MSWUE.

13.6.2 Toolbar order and grouping

1. Each toolbar shall have a hierarchical order, such that if multiple toolbars are displayed they will be ordered consistently on the display.

2. More commonly used toolbars shall be placed on top of less commonly used toolbars with the main toolbar being located directly under the pull-down menu bar.

3. Icons shall be ordered in groups with spaces between icon groups (e.g., all editing icons would be together and delimited by a space and separator line followed by all formatting icons.)

Source

CSFAB.

Discussion

G3. See MSWUE for design details.

13.6.3 Toolbar windows

1. All toolbars shall be able to float by selecting any region inside the toolbar and moving it to another display location.

2. The floating toolbar window shall then be able to be closed, sized, or moved to any other display location like a normal window.

3. If the toolbar window is moved back over the pull-down menu or another toolbar, the toolbar window shall be converted back into a standard toolbar and placed under the pull-down menu bar in its toolbar hierarchy.

4. Toolbar windows shall be on the same visual layer as their parent application and shall have shared focus with their application.

5. An application action icon palette or toolbar shall be able to be repositioned or removed from the window if desired by the user.

6. A palette or toolbar displayed in its own window containing action icons shall always remain on top of the window to which it pertains.

Source

CSFAB, TBM.

13.6.4 Toolbar Icons

1. Action icons shall be presented together on a palette or toolbar. A toolbar presentation places action icons next to each other in either a horizontal or a vertical alignment. A palette presentation places action icons in a matrix alignment.

2. Application action icon palettes shall appear, by default, along the left margin of the window. Application toolbars shall appear, by default, beneath the menu bar.

3. An application action icon palette shall contain no more than 20 action icons and an application toolbar shall contain no more than 30 action icons.

4. If numerous or non-standard action icons are used a command or an abbreviated form of the command shall be placed beneath the icon. A toolbar presentation of action icons shall always have labels.

5. A palette presentation is generally reserved for graphical tools. Since the graphics on the action icon resemble the graphics produced, text labels may be omitted when action icons are presented in a palette. Tool tips shall be employed for tools in a palette presentation.

6. An action icon palette and toolbar shall support navigation and selection from the keyboard.

Source

TBM, UCA.

Discussion

Option buttons are called radio buttons in Motif style guides.

G6. This shall be accomplished by the same means as any push button activated from the keyboard.

13.7 Option buttons

Option buttons allow users to select one option from a group of mutually exclusive options. The option buttons illustrated below are typically found on the Print dialog box for Microsoft applications whereby the three "Page range" options allow the user to select one of three distinct settings for printing the document.

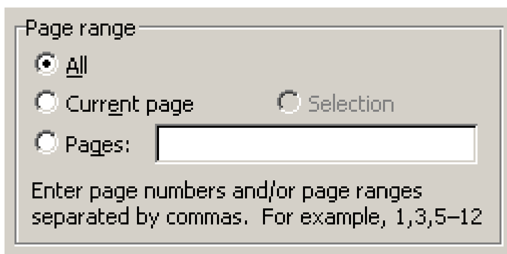


Figure 13: Example of option buttons.

13.7.1 Option button characteristics

1. An option button shall be used to select one option from a group of mutually exclusive options.

2. One option button must be selected from each mutually exclusive group at all times. If no selection is a valid option then a choice labelled “None” shall be provided.

3. When option buttons are used, they shall provide a sufficiently large target to be easily operable under expected Maritime conditions.

4. Option button indicators shall be the same size throughout the application.

5. Option buttons shall not be used to initiate actions or open dialog windows.

6. The label of an option button shall define the state set by the user.

7. The label text shall be displayed in mixed case with the first letter of the option capitalized.

8. When the option button(s) are selected but not executed, the application shall not save the selection and the option button(s) shall return to their original state when the window is displayed.

Source

CSFAB, TBM, UCA.

Discussion

G3. The active area for an option button can be visually enhanced by displaying the entire active area of the button to the operators. Even advanced users tend to use the small target of the option button graphic rather than the entire active area. The standard option button size presents too small a target to be used for Maritime operations.

13.7.2 Option button order and grouping

1. Option buttons shall be arranged in vertical groupings.
2. A group of option buttons shall provide no more than eight alternatives and shall include a title that describes the type of information being presented.

Source

CSFAB, TBM.

Discussion

G1. CSFAB indicates that horizontal groupings may be used if space requirements so dictate.

13.7.3 Option button selection

1. The S button on the pointing device shall be used to select an option button.
2. When the location cursor is on an option button then <Space> (and <Select>, if available) shall select an option button from the keyboard.
3. When an option button is selected, it shall be highlighted and any other selected button in that option box group shall be deselected.
4. If an option button is in a window with a default action, <Enter> or <Return> shall execute the default action.
5. If an option button is unavailable for selection, its label shall be greyed out to indicate its unavailability.

Source

TBM.

13.8 Toggle buttons

Toggle buttons allow users to alternate between two states for a given object using a single button. For example, the Show/Hide button on a toolbar can be pressed to display the formatting symbols in a Microsoft Word document. For the "Show" state, the button remains visually pressed (left figure in Figure 14) until the user clicks the button again and reverses the setting to the "Hide" state (right figure in Figure 14).

Figure 14: Example of a show/hide toggle button.

Another implementation of a toggle button is the Maximize/Restore (middle) button found on the top right corner of Microsoft windows. When the window is not maximized, the Maximize button is displayed to denote the ability to perform the “Maximize” action. When the window is maximized, the Restore button replaces the Maximize button thereby indicating the ability to return the window to its previous state.

Figure 15: Example of a maximize/restore toggle button.

13.9 Toggle button characteristics

1. The toggle buttons may be modified so that they appear as push buttons. However, the resulting behaviour is that such a "push button" remains highlighted when <Select> is released and returns to its previous appearance only when another button of the same type is selected. This scheme shall be implemented when buttons are used to both execute an action and to provide an indicator of the action selected. The column headings in multi-column list boxes shall be toggle buttons that look like push buttons.

2. Include both states of the settings on the menu as individual menu items and interdependent choices. The operator may then view both options at once. Use toggles and toggled labels only if there is insufficient room to display both of the toggled options.

3. Toggle buttons and indicators in menus shall be visible when in the off state.

4. Settings that are state toggles shall be worded to describe a state (e.g., a list of font names) and may be indicated by option buttons or check boxes to the left of the option. (TBM, CSFAB)

5. Only one of the actions for a toggle menu option shall appear in the menu at any time.

Source

CSFAB, TBM, MSWUE.

13.9.1 Toggle button labels

1. If there is not sufficient room to display both of the toggled options, then settings that are action toggles (e.g., turn on/turn off) shall be worded to reflect the action that is implemented when the option is selected and shall change to reflect the opposite action that will occur if the toggle is selected again.

2. When a state toggle is selected, the indicator shall change state without altering the wording.

3. When an action toggle is selected, its wording shall change to reflect the action that will be implemented when the action is selected again (e.g., if a menu option is worded Show Tool Bar it will be changed to Hide Tool Bar after it has been selected).

4. Wording of an undo option shall change dynamically to reflect the action to be undone. For example, if the most recently executed action is “Cut”, the option shall be worded “Undo Cut”.

5. Wording of an action toggle option shall reflect the action implemented when the option is selected. For example, if a menu action toggle is being used to show political boundaries on a map, the menu option shall be worded “Show Political Boundaries” rather than just “Political Boundaries” to indicate that political boundaries will be displayed when the option is selected.

6. Wording of an action toggle option is semantically congruent with natural usage. For example, if one toggle is worded “Move Object Up” the other toggle shall be “Move Object Down” rather than “Move Object Back”.

Source

CSFAB, TBM, MSWUE.

Discussion

G1. Action toggles that use changed wording to convey the action that will happen when the toggle is selected should not be displayed in the pressed state because users find it unintuitive to press a button that is already pressed.

13.10 Check boxes

Check boxes allow users to toggle the state or setting for option(s). The example shown below is of a check box implementation that allows the user to adjust the various Pagination settings for a Microsoft Word document.

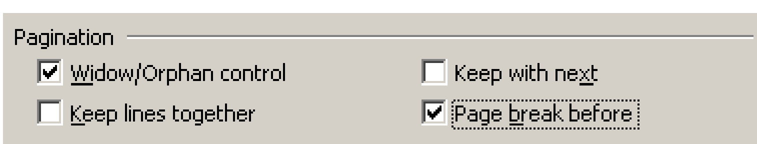


Figure 16: Example of check boxes.

13.10.1 Check boxes characteristics

1. A check box shall be used to set options in an application.

2. A check box shall be a non-exclusive setting; selecting a check box toggles a setting or state.

3. Check boxes shall not be used to initiate actions or open dialogs.

4. Check boxes shall be used singly or in related groups.

5. Check boxes shall be displayed in vertical groupings, but horizontal grouping is permitted if more beneficial due to space requirements.

6. The number of check boxes in a group shall be limited to eight or less and shall include a title that describes the type of information being presented.

7. When check boxes are selected but not executed, the application shall not save the selection and the check boxes shall return to their original state when the window is displayed.

Source

CSFAB, TBM.

13.10.2 Check box size

1. Check boxes shall be the same size throughout the application.

2. Check boxes shall be of sufficient size to be suitable targets in Maritime operations.

Source

TBM, UCA.

Discussion

G2. The active area for a check box can be visually enhanced by displaying the entire active area of the button to the operators. Even advanced users tend to use the small target of the check box graphic rather than the entire active area. The standard check box size presents too small a target to be suitable for Maritime operations.

13.10.3 Check box interaction

1. The S button on the pointing device shall be used to select a check box.

2. When the location cursor is on a check box, <Space> (and <Select> if available) shall select a check box from the keyboard.

3. When a check box is selected, it shall be highlighted and any other button in that check box group which has been previously selected shall stay selected.

4. If a check box is in a window with a default action, <Enter> or <Return> shall execute the action.

Source

TBM.

13.11 List boxes

List boxes are used to view and scroll through several related items. The illustrated list box provides the user with a list of several toolbar types.

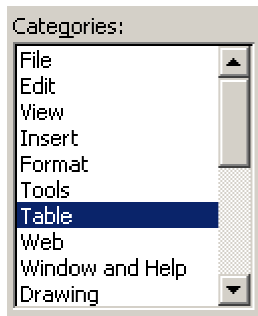


Figure 17: Example of a list box (taken from Microsoft word).

13.11.1 List box characteristics

1. The items in a list shall be displayed vertically, with one item per line. In general, a list box shall be large enough to display six to eight items at a time or all of the items if there are fewer than six.

2. The title of the list shall describe its purpose or contents and appear above the box.

3. A vertical scroll bar shall appear to the right of the list when items exceed space available.

4. A list shall scroll only in response to user actions such as using a scroll bar or conducting a speed or incremental search. A list does not scroll automatically (e.g., whenever the contents of the list are updated through an automatic process or a user generated process such as editing a list item).

5. A list shall be wide enough to read the items without having to scroll horizontally. If items differ significantly in length, then the list box shall be wide enough to display the items of average length and include horizontal scroll bars to allow longer items to be read.

6. List items shall appear in sequential order based on the nature of items and sequence expected (e.g., chronological, alphabetical, sequential, functional, and by importance).

7. A series of list boxes may be arranged horizontally in a row to form a multi-column list box or matrix.

8. In multi-column list boxes, the list box titles serve as the column headings in the matrix, and the items in each list form the records that appear in the rows. Users shall be able to sort the records by selecting the column heading. With this approach, the headings of columns that can be sorted appear as push buttons, and when users select a heading the records in the matrix are sorted in ascending order (e.g., numerical or alphabetical) based on the items in the column.

9. Items added to a list shall appear in their correct position in the list, not at the end of the list.

10. The list shall not automatically scroll to the new item except during initial entry. Only user initiated scroll is permitted.

11. Vertical extension. Where lists extend over more than one display page, the last line of one page shall be the first line on the succeeding page.

12. Marking multi-line items in a list. Where a single item in a list continues for more than one line, such items shall be marked in some way (e.g., blank line, indentation) so that the continuation of the item is obvious.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE.

Discussion

G4. Auto-scrolling is acceptable when the user is adding new items to a list. When new items are added, they shall appear in the default sort order of the list and the list shall automatically scroll to place the newly added item at the top of the list.)

G8. For a description of column heading controls, see MSWUE (Chapter 8).

13.11.2 List box navigation and selection

1. Lists in which users can select an item(s) upon which to perform an action shall use a pop-up menu to display these options. Push buttons shall be used to provide redundancy for options displayed in the pop-up menu. Push buttons shall be used when there is a standard push button assignment

2. In an initial list box display, the current selection or a default selection shall be highlighted and the list scrolled to place this item at the top of the list box.

3. Users shall search a list by moving the scroll bar slider until the item appears. The arrow keys shall also scroll the items in a list.

4. Applications shall provide a speed search capability in all list boxes. Speed search allows the user to type the first letter of the selection to quickly move to those options beginning with that letter.

5. In list boxes where the number of items is expected to be large (e.g., in excess of 20 items), speed search shall be implemented. In speed search the user must place the

location cursor on the list. When the user types the first letter of the item, the list shall scroll to the first instance that begins with the letter the user types.

6. In list boxes where the number of items is expected to exceed 50 items, incremental search shall be provided. When the user types the first few letters in the text field and presses <Return>, the list shall scroll to the first match.

7. Speed search and incremental search shall not be case-sensitive. If case-sensitivity is a user requirement, then this information is provided to users.

8. The S button on the pointing device shall be used to select item(s) in a list box.

9. List items shall be selectable by both the pointer and the keyboard. Lists can allow for either mutually exclusive selection or multiple selections.

10. The <Space> key (<Select> if available) shall selects item(s) in a list from the keyboard.

11. If a window has a default action, double clicking on an item chooses the item and executes the action. However, double clicking shall not be the only means to execute the action.

Source

CSFAB, TBM.

13.12 Scroll bars

Scroll bars allow users to view textual or graphic information when that information exceeds the available display area in the window. Below is a horizontal scroll bar with the various components labelled. If scroll bars are required, vertical scroll bars are preferred.

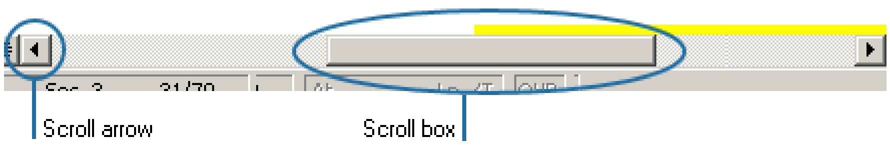


Figure 18: Example of a scroll bar.

13.12.1 Scroll bar characteristics

1. If scroll bars are needed, they shall be located to the right or at the bottom of the area being scrolled.

2. Scroll bars shall be used to view textual or graphic information when it exceeds the available display area in the window. All text shall wrap so that it can be read continuously without horizontal scrolling. Horizontal scrolling shall be avoided. If a scroll bar is not needed it shall be removed from the display.

3. Items continued on a following page (scrolled) shall be numbered relative to the last item on the previous page.

4. Users shall be able to scroll to the top or the bottom of the scroll region but not beyond.

5. Relative slider position shall indicate relative position of information currently displayed in the window.

6. Scroll bar tips shall be provided. The scroll bar tips shall be implemented in accordance with Microsoft Windows conventions.

Source

CSFAB, TBM, DISA, MS1472F, UCA.

Discussion

G7. Scroll bar tips are similar to Tool Tips and are displayed when the user presses the scroll bar thumb (the button in the centre of the scroll bar trough.) Scroll bar tips are described in Developing User Interfaces for Microsoft Windows [46].

13.12.2 Scroll bar navigation and selection

1. Pressing the S button on a stepper arrow shall move one unit in the arrow direction. A unit is defined as a column for a horizontal scroll bar and a line for a vertical scroll bar.

2. Pressing the S button on a trough shall move one page (less one unit) in the direction indicated. A page is defined as one window length for a vertical scroll bar and one window width for a horizontal scroll bar.

3. Dragging the slider with the S button shall move the slider in the pointer direction.

4. The virtual <Cancel> key shall return the slider to its position before the sliding operation began.

5. Dragging past the top/bottom of the scrollable area shall make the window scroll in the pointer direction.

6. The speed of autoscrolling shall be the same as when the users press on a stepper arrow.

7. Scrolling shall stop when users move the pointer back into the control or when users release the Select button on the pointer device.

8. Arrow keys shall move the slider one unit (e.g., one line or column) in the arrow direction.

9. Pressing <Ctrl> with the arrow keys shall move the slider one large increment in the arrow direction.

10. <PageUp>, <PageDown>, <PageRight> (or <Ctrl> + <PageUp>), and <PageLeft> (or <Ctrl> + <PageDown> shall page the screen in the specified direction.

11. <Ctrl> + <Begin> and <Ctrl> + <End> shall scroll to the beginning/end of the scrollable region.

Source

TBM, DISA.

13.13 Scales

A scale is used to set or display a value in a continuous range. To adjust the values along a scale, a slider can be implemented whereby the user can drag the pointer across specified positions along the line. The slider illustrated below provides the capability to adjust the speed with which the pointer moves within the Microsoft operating system.

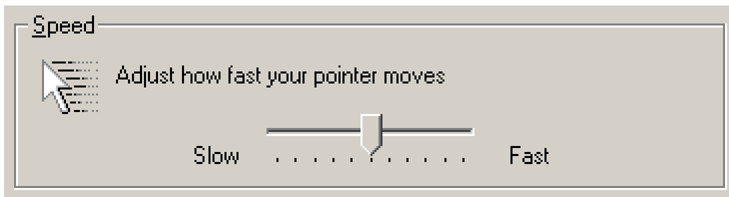


Figure 19: Example of a scale.

13.13.1 Scale characteristics

1. A scale shall be used to set or display a value in a continuous range.

2. A scale may contain tick marks and is labelled with minimum/maximum values for the scale.

Source

CSFAB, TBM, DISA.

Discussion

G2. A scale can only be used with numeric values. This limits its use. The scale shall be used where users are primarily operating with a pointing device to help reduce transitions between the keyboard and pointing device. A scale may also be used in an output only mode. This is sometimes called a gauge. The value of using a scale in this mode is that by displaying minimum and maximum values, users can quickly see the present setting in a continuum and have an idea how far the setting is from the extreme values.

13.13.2 Scale navigation and selection

1. Users shall display a value by adjusting a slider (bar or arrow) to a specified position along a line. A scale shall contain a slider marking the currently chosen scale value, and a label above or next to the slider showing the current value of the scale.

2. Pressing the S button on the scale bar shall move one increment at a time in the direction indicated.

3. Dragging the slider with the S button shall move the slider in the pointer direction.

4. <Cancel> shall return the slider to its position before the sliding operation began.

5. Arrow keys shall move the slider one unit in the arrow direction.

6. <Ctrl> with the arrow keys shall move the slider one large increment in the arrow direction.

7. <Ctrl> + <Begin> and <Ctrl> + <End> shall move the slider to minimum/maximum scale values.

Source

CSFAB, TBM.

13.14 Other controls

13.14.1 Other control characteristics

1. If a non-standard control is used, it shall have as much of the standard look and feel as possible.

2. Non-standard controls shall maintain a three-dimensional appearance since they are controls and can be manipulated by the user.

Source

TBM, UCA.

13.14.2 Modified push button behaviour

1. When push buttons are used to execute an action and provide an indicator of the action selected, the push button may be modified so that it stays highlighted.

2. A push button palette may be used to provide access to a set of frequently performed actions.

3. Push buttons in a palette shall represent a set of mutually exclusive options.

Source

TBM.

13.14.3 Drop-down combination boxes

Similar to a list box, a drop-down combination box uses the standard text field and list widgets. A drop-down combination box allows the selected item to be set off from the list and allows for subsequent letter speed search instead of only first letter speed search. As shown below, these boxes allow the user to create a new file name or select from a pre-defined list of file names as well as to select a format for saving the file.

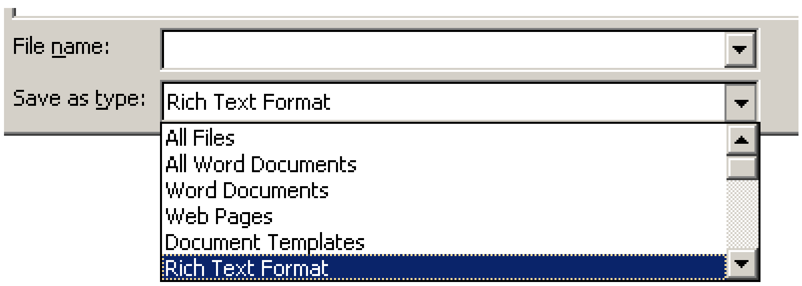


Figure 20: Example of a drop-down combination box.

1. Drop-down combination boxes are used to fill a text field when the number of valid entries in the field is limited or very large.

2. Combination boxes combine the standard text field and list widgets. This allows the selected item to be set off from the list and allows for subsequent letter speed search instead of only first letter speed search.

3. Combination boxes are generally used for long lists but could be substituted for any list with mutually exclusive selections. They may be implemented in standard or drop-down mode.

4. See MSWUE for the appearance and behaviour of combination boxes.

5. The availability of a drop-down combination box shall be indicated by an arrow push button to the right of the text field.

6. Items in a drop-down combination box shall allow users to select from valid entries or cancel the selection.

7. Drop-down combination boxes shall be wide enough to read items in the list and include vertical scroll bars if necessary.

Source

CSFAB, TBM, UCA.

13.14.4 Spin boxes

Spin boxes consist of a text field with arrows attached to the right side of the text field. The arrows are organized with an upward pointing arrow above a downward pointing arrow. Pressing the arrow buttons allows the user to increment (or decrement) the value in the text field. The spin boxes illustrated below provides the user with the ability to change the spacing before and after a paragraph in a Microsoft Word document.

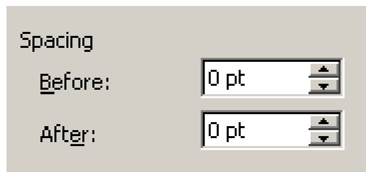


Figure 21: Example of a spin box.

1. Spin boxes are specialized text fields and shall accept only a limited set of discrete, ordered data entry values. A spin box shall consist of a text field with an upward pointing arrow above a downward pointing arrow attached to the right side of the text field.

2. If space is at a premium and if the usability of the CCS is not negatively impacted, a spin box may be used instead of a scale. Spin boxes are also slower to use than scales when using a pointing device, as the operator must step through all values to reach a desired value.

3. The designer shall define the increment values for the spin box. Pressing the up or down arrow shall change the existing counter value to the next higher or lower increment.

4. A spin box shall allow a user to type into the text field, click the up arrow to increase the value in the text field, or click the down arrow key to decrease the value in the text field.

5. If a user presses the up arrow or the down arrow and holds the selection pointer down, the text field shall step through its values continuously in the direction of the arrow button until the selection pointer button is released. When either end of the scale is reached, the value shall wrap around to the other end and continue stepping through the list until the selection pointer button is released.

6. If spin boxes are used to display values that consist of several subcomponents, the text component is divided into text fields separated by suitable separators and the arrows affect the selected text field.

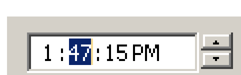


Figure 22: Example of a Component Spin box. It has several subcomponents with the text fields separated by colons whereby the arrows affect the highlighted text field (i.e., minutes).

7. A value typed into a spin box shall be validated for correct syntax and format as the user leaves the text field widget.

8. Spin boxes shall not be used if there is a more direct way to select the values. (An example of a direct way to select values is selecting dates via a calendar widget.)

Source

CSFAB, TBM, UCA.

Evaluation methods and measures

Design verification:

- Verification of ease of use, design consistency, and visibility of all controls used in the OMI.

Operator performance:

- Objective assessment of use and usefulness of controls.

Operator acceptance:

- Subjective assessment of the adequacy of the operator's perceptions of usability, utility, and consistency of controls in the OMI and ESS.

14 Menus

Menus provide a means for the operator to access functions in a hierarchical fashion that requires decreased display space and decreased cognitive requirements. While this means of accessing functions requires less memorization, it is generally slower for experienced operators who have already learned common function keys. The deeper a function is located in a menu hierarchy the longer it will take to access that function and the more difficult it will be to remember how to navigate to that function.

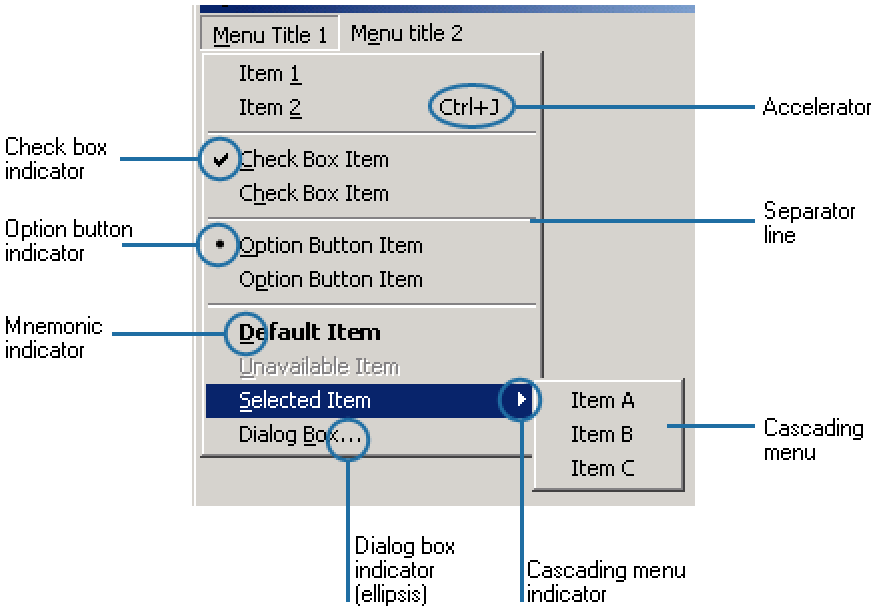


Figure 23: Illustration of several generic menu characteristics in accordance with the requirements defined in this section.

14.1 Menu characteristics

1. Menu titles, controls, separators, access keys, layouts and other details are presented in MSWUE (Chapter 8). The Microsoft windows visual layout shall be followed.

2. The number of hierarchical levels used to control a process or sequence shall be minimal.

3. Those functions that are used frequently or are time critical shall be accessible via a single action. This group of functions may change depending on the task being performed and shall be reflected in the menus required during these tasks. If the function needs frequent access, then a single layer menu is required.

4. Display and input formats shall be similar within hierarchical levels of menus. The system shall indicate the current positions within the sequence at all times.

5. Menus shall be used for tasks that involve little or no entry of arbitrary data and where users may have relatively little training. Menus shall also be used when a command set is so large that users are not likely to be able to commit all of the commands to memory.

6. Menu groups are related menu options within the same menu window. Grouping allows operators to more quickly scan options by skipping entire groups of options until the desired group is located. Each menu group shall be separated from other groups and contain a limited number of options.

7. Options shall not be added to or deleted from a menu to indicate their availability within a particular part of an application.

8. A menu shall not consist of a long list of multi-page options, but shall be logically segmented to allow several sequential selections among a few alternatives.

9. On any type of menu, a menu option that displays a window shall be followed by an ellipsis (...).

10. A routing option that displays a cascading submenu shall be followed by a right-pointing arrow.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE, UCA.

14.2 Menus organization and grouping

1. The number of levels required to access a specific function is referred to as the depth of the menu. To increase function access speed, a broad and shallow menu tree shall be used. *Broad* meaning that each level in the menu tree contains many functions and *shallow* meaning that the menu tree shall only contain two functions.

2. The limit on the number of levels is determined by the number of actions required to activate an option. No matter where the operator is in the menu hierarchy, the operator shall be able to access any function with only three actions (e.g., one press to get back to the main level, one press to select the proper group of functions, and one press to select the desired function).

3. Single layer menus shall be used for reserved commands that never change and must always be available to the operator. Fixed Action Buttons (FABs) are a common type of single layer menu and can be virtual or real buttons that provide the operator with immediate access to a set group of commands.

4. When menu traversal can be accomplished by clearly defined hierarchical paths, the user shall be given some indication of the displayed menu's current position in the overall or relevant structure (e.g., an optional display of path information or cascading menus).

5. The user shall be able to return to the next higher level of hierarchical menus by using single key action until the initial, top-level menu or display is reached.

6. A function shall be provided to directly recall the initial, top-level menu or display without stepping through the menu or display hierarchy.

7. Dialog boxes shall be used as an aid for composing complex control entries. For example, a displayed form might help a user invoke the various format controls that are available to complete a print request.

8. Structured menus shall be used to provide access to functions when space and cognitive memory resources are limited. By segmenting functions into common menus and/or groups, only those functions that are required for a specific task are available thus reducing clutter.

9. The display of information accessed by tabs (e.g., menus based on an index card tab concept) shall not include more than one layer of tabs.

10. The display of information accessed by tabs shall clearly indicate which tab is selected. The selected tab shall appear to be in front of the remaining tabs.

11. When a tab is selected the outline of the selected page shall appear in front of the remaining pages.

Source

CSFAB, MS1472F, UCA.

14.3 Menu mnemonics

1. Mnemonics shall be available for every title in a menu bar and every option in all menus.

2. The mnemonics assigned to titles in a menu bar, and to options within a menu, shall be unique.

3. A menu title or option shall have the same mnemonic whenever it appears in an application.

4. The mnemonics listed in MSWUE shall be used in menu titles and options.

5. The same mnemonic shall not be used for options performing opposite or contradictory actions.

6. Letters shall be used for mnemonic codes if they relate to the spelling of the command. However, letters that do not relate to a command shall not be used because they are worse than numbers.

7. Numbers are useful for sequential lists and for easy location by non-typists. If numbers are used as mnemonics, one (1) shall be used for the first option, do not use zero (0).

8. Similar key(s) shall be used in the mnemonic and keyboard accelerator for a menu option.

9. The character assigned as the mnemonic for a menu title or menu option shall be underlined.

10. Whenever possible, the mnemonic shall be the first letter of a menu title or option.

11. If the mnemonic is not the first letter, the mnemonic shall be another character in a menu title (or option) rather than more arbitrary numeric codes.

12. If the mnemonic character does not appear in a menu title or option, it shall be in parentheses after the label.

13. Mnemonics shall not be case-sensitive.

14. If the location cursor is in the menu bar, typing a mnemonic shall display the associated menu.

15. When a menu is displayed, typing a mnemonic shall select the associated option.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE.

14.4 Menu wording, organization, and availability

14.4.1 Menu wording

1. Each option shall be phrased to reflect the action that is executed or the object that is modified by the option (i.e., phrased as a command to the computer rather than as a question to the user).

2. Options shall be worded in the vocabulary of users rather than that of application developers or other populations.

3. The vocabulary listed in MSWUE shall be used whenever actions are included in an option (e.g., Save, Cut, Delete, and Find). Whenever an action is available in OSF/Motif that is not identified in Windows then the Motif vocabulary shall be used.

4. The key word of the command shall be the first word in the option.

5. Each option shall be tersely worded (preferably limited to a single word) and follow book title capitalization rules. (CSFAB, MSWUE)

6. Acronyms in menu option titles shall be capitalized.

Source

CSFAB, TBM, DISA, MSWUE, UCA.

14.4.2 Menu organization

1. Each menu option shall be left justified and appear on a single line; long menu options shall be accommodated by making the menu wider rather than making the item take two (or more) lines.

2. Menus shall be presented in a consistent format throughout the system and shall be readily available at all times.

3. When selections are indicated by coded entry, the code associated with each option shall be included on the display in a consistent manner.

4. If several levels of hierarchical menus are provided, a direct function call capability shall be provided such that the experienced user does not have to step through multiple menu levels.

5. The menu shall be wide enough to accommodate the longest option and accelerator.

Source

CSFAB, TBM, MS1472F, MSWUE.

Discussion

G5. An accelerator is a keyboard key or key combination that invokes a particular command. Some references distinguish between accelerators (key combinations, for example <Ctrl> + <Z> for Undo) and short cut keys (function keys). Other references refer to both the key combinations and functions keys as accelerators. In this document the term accelerator refers to both function keys and key combinations.

14.4.3 Menu option grouping

1. Menu options shall be organized in logical or functional groupings. Options that are related shall be divided by a separator line. The separator line is a single line that spans the width of the menu. Separation into groups will allow operators to more quickly find a desired option.

2. The maximum number of menu titles in the main menu bar shall be nine.

3. The number of options in a pull-down menu shall be limited to fourteen.

4. As a guideline, a menu shall contain no less than three options or more than ten options.

5. The number of options in each menu group shall be limited to five.

6. Menu items themselves shall not be used as group separators in menus.

7. If the menu options are not ordered in logical groups, options shall be ordered by frequency of usage, with the most frequent at the top.

8. If the menu options are not ordered in logical groups or by frequency, options shall be ordered in alphabetical or numerical order.

9. Less frequently executed options and destructive options shall be at the bottom of the menu.

10. If similar options are in different menus, the options shall be ordered in a consistent manner.

11. Menus with more than four to five options shall be divided into subgroups of options, as appropriate. Groups of menu options are separated by a separator line.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE.

14.4.4 Menu Availability

1. If an option or set of options is never available to a user, the option(s) shall not be presented in a menu.

2. If an option is only temporarily unavailable, it shall be displayed in the menu but dimmed to indicate that it cannot be selected. The dimmed function remains visible to indicate or confirm that this option does exist but is not available due to the status of the system.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE.

14.5 Menu navigation and selection

14.5.1 Pointer navigation and selection

1. When a menu is displayed, the location cursor shall appear on the first available option in the menu.

2. When the S button is clicked on the menu title the menu shall remain displayed.

3. Posted methods shall be used to display a menu and select an option.

4. When the S button is clicked on the option, the location cursor shall move to the option and the option shall be selected. The menu shall then be removed.

5. To dismiss the menu without selecting an option, the pointer shall be moved off the menu and the S button clicked.

Source

TBM, MSWUE.

Discussion

G3. TBM include spring-loaded methods.

14.5.2 Keyboard accelerator navigation and selection

1. Accelerators shall be available for menu options that are frequently executed.

2. Accelerators consistent with the Microsoft Windows styles shall be used for the actions listed.

3. Accelerators shall be right justified, on the same line, and separate from the option label.

4. Users shall be able to execute keyboard accelerators available in the window with input focus.

5. Keyboard accelerators containing an alphabetic character shall not be case-sensitive.

6. The same key combinations shall be used for accelerators throughout the application/system.

7. Key combinations for accelerators shall not conflict with mnemonics/text entry keystrokes.

8. No combination of adjacent keys shall alone be used as an accelerator. This reduces the chance of accidentally performing a function while typing.

9. Accelerators shall not be a combination of <Alt> and letter keys (which might conflict with mnemonics) or a combination of <Shift> and letter keys (which might conflict with keystrokes used in text entry).

10. Fixed function key interactive control may be used for tasks that require only a limited number of control inputs or in conjunction with other dialogue types

Source

CSFAB, TBM, DISA, MS1472F, UCA.

14.6 Menu title

1. The title of a pull-down menu shall be displayed in a menu bar at the top of a window. If possible, a menu title shall be limited to one word.

2. A menu title shall describe the category or type of options and shall be different from other menu titles that appear in the same menu bar.

3. The first letter of each word in the menu title shall be capitalized, in accordance with book title conventions.

4. If a menu title contains an acronym, the acronym shall be capitalized.

5. A menu title shall not contain an ellipsis or right-pointing arrow.

6. The Help menu title shall be right-most item on the menu bar.

7. Menu titles in a menu bar shall have an equal amount of space between each title.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE.

14.7 Menu types

14.7.1 Pop-up menus

Pop-up menus provided quick access to actions that can be performed on the selected object. The Pop-up menu illustrated below is displayed when a user right-clicks while editing text in a Microsoft Word document.

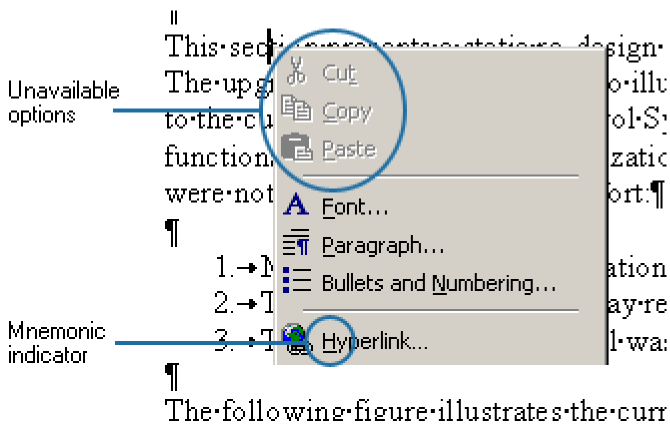


Figure 24: Example of a pop-up menu.

14.7.1.1 Pop-up menu characteristics

1. Means for accessing pop-up menus shall be one of the following:
   - Button Press. A pop-up display mode can be implemented through the use of the right-hand button on the input device.
   - Time. In the time mode, the pop-up menu is only displayed if the pointer remains over an object for a given period or if an input is held for a given time (as with Tool Tips).
   - Pre-selection. In the pre-selection mode, the pop-up menu can be displayed by simply moving the cursor over an object.
2. Pop-up menus shall be consistent with Microsoft Windows styles.
3. Pop-up menus shall not include cascading submenus.
4. The options in a pop-up menu shall include mnemonics but not keyboard accelerators.
5. The options in a pop-up menu shall be dimmed when unavailable.

6. When a pointing device is used, the pop-up menu contents shall relate to the element with the pointer.

7. When a keyboard is used, the pop-up menu contents relate to the element with the location cursor.

8. A pop-up menu shall appear near the element with which it is associated.

9. If the pop-up menu is not related to a specific object then it shall be displayed at the pointer location.

10. If related to an object, the menu options shall be specific to functions performed on that object.

11. A window containing a pop-up menu shall provide an indication that the menu is available.

12. A pop-up menu shall provide redundant access to actions and shall not access new actions. This means that options in a pop-up menu must also be accessible via a main pull-down menu or push buttons.

13. A pop-up menu shall not include check boxes to turn settings on and off.

14. A pop-up button-press menu shall be hidden from view and be displayed only when selected by the operator.

Source

CSFAB, TBM, DISA, MSWUE, UCA.

14.7.1.2 Pop-up menus

1. Posted methods shall be used to display a button-press pop-up menu.
2. Spring-loaded methods shall be used to display time or pre-selection pop-up menus.
3. The right-most button on a two-button pointing device shall display pop-up menus.
4. When a pop-up menu is displayed, the location cursor shall be positioned on the first available option in the menu.
5. <Select> or <Menu> shall select a menu option and dismiss the menu.
6. <Shift> + <F10> (and <Menu>) shall display a pop-up menu.
7. Arrow keys shall move the location cursor between available options in a pop-up menu.
8. <Return>, <Enter>, or <Space> (and <Select>) shall select an option and shall dismiss a pop-up menu.
9. When an option is selected with a pointing device or keyboard, the pop-up menu shall be dismissed.
10. Cancel and <Shift> + <F10> (and <Menu>) shall dismiss a pop-up menu without making a selection.

Source

CSFAB, TBM, DISA, MSWUE.

14.7.2 Pull-down menus

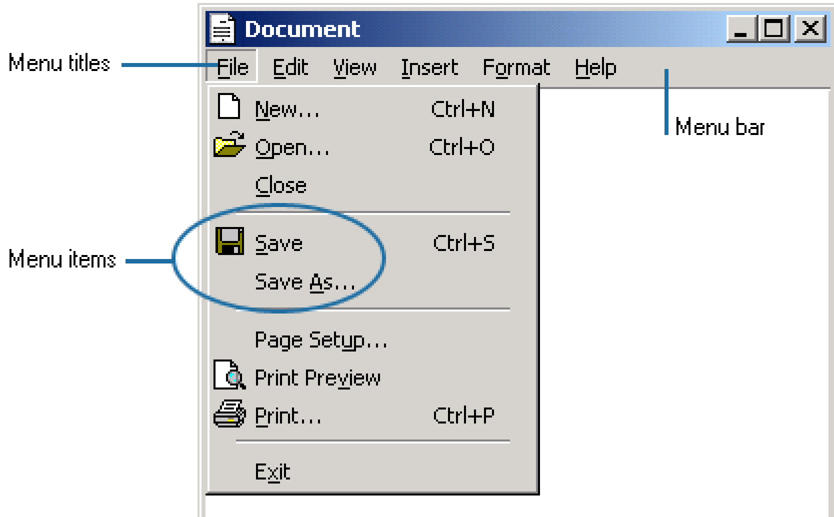


Figure 25: Example of a standard pull-down menu.

1. Posted menus operations shall be used for pull-down menus. In posted menus, the pull-down menu appears when the operator selects a pull-down menu title and remains visible even if the selector is released.

2. Pull-down menus shall be avoided when the location of the pull-down menu is such that it may cover time critical information such as tactical plots.

3. An application shall have only one pull-down menu bar that is displayed upon entering the application and only removed when the application is closed.

4. Hard keys and controls (such as hard range keys) shall be redundantly placed in the pull-down menus.

5. A pull-down menu shall consist of a menu bar, titles and a set of options or commands below each title. The menu bar shall be located along the top margin of a window.

6. Book title capitalization shall be used in the menu item text.

7. Each menu title shall have an associated pull-down menu that contains groups of options. Each option shall include a unique mnemonic access key.

8. The menu shall be wide enough to accommodate a tool bar icon, the wording of the longest menu option, and a keyboard accelerator.

9. A minimum of five spaces shall be provided between the icon, the option, and the accelerator so each can be easily distinguished by the user.

10. Menu items that are arranged in columns or accessed by scrolling shall not be used.

Source

CSFAB, MSWUE.

14.7.3 Option menus

1. An option menu shall be used to make a mutually exclusive selection from a list of options. Option menus are helpful in that users do not have to type in data, remember codes, and thus the users make fewer data entry errors.

2. The options in an option menu may include mnemonics but do not include keyboard accelerators.

3. Posted methods shall be used with the S button to display an option menu.

4. When an option menu is displayed, the location cursor shall be on the previously selected option.

5. Spring-loaded and posted methods shall be used with the S button to navigate within and make selections in the option menu.

6. When an option is selected in an option menu, it shall appear as the label in the option menu button.

7. Either <Space> or <Select> shall display an option menu.

8. Arrow keys shall move the location cursor between available options in an option menu.

9. <Return>, <Enter>, or <Space> shall select an option and dismisses an option menu. If the keyboard has a <Select> key, it shall also select an option and dismiss the option menu.

10. Cancel shall dismiss an option menu without making a selection.

11. Options shall normally be listed in alphabetical or numeric order but other groupings may be more suitable for specific tasks.

12. If the operator must scan the option list and determine a proper option, the list shall be limited to nine options.

13. The number of options shall only be limited to the display size if the operator is looking for a known specific value.

14. If the number of options cannot be displayed simultaneously on the display then either a scrolling option menu or a list box shall be used.

15. If more than 50 options are available, a combination text box and list box shall be used.

16. Option menus shall use first character speed search.

17. The display and operation of option menus shall follow the Microsoft Windows conventions.

Source

CSFAB, TBM, MSWUE.

14.7.4 Cascading Submenus

1. Cascading submenus shall appear to the right of the parent menu and to the left if the space to the right is limited.

2. Cascading submenus shall be limited to two levels (one level below the main pull down menu).

3. Cascading submenus shall not repeat the parent option as the first option in the submenu.

4. The submenu shall be positioned so the first option is aligned with the right-pointing arrow in the parent option for the submenu.

5. Cascading menus are most useful to display user access to additional choices rather than using more space in the parent menu. Cascading menus shall not be used for frequent or repetitive commands.

Source

CSFAB, TBM, DISA, MSWUE.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of all menus used in the OMI.

Operator performance:

- Objective assessment of use and usefulness of menus through usability testing.

Operator acceptance:

- Subjective assessment of the adequacy of the operator's perceptions of usability, utility, and consistency of menus in the OMI and ESS.

Relationship to other guidelines

15 Windows states, components, and operations

15 Windows states, components, and operations

15.1 Overview

Windows are used to show separate applications or groups of information on the same screen. They can be manipulated to best display the required information to solve the problem at hand. However, certain windows in combat systems need to be in fixed locations to ensure the operator can quickly and easily find important information. Windows are always arranged in a hierarchy with the root window being the parent of all windows. Any time a window is invoked, it becomes the child of the window from which it is called.

15.2 Window states

15.2.1 Window state characteristics

1. Windows must always be in one of three states: Open, Minimized, or Closed.

2. Multiple windows may be open at any one time and may partially obscure other windows provided the obscured window is not a fixed window.

3. An active window that does not need to be kept open may be minimized. A minimized window shall be replaced by a button that shall be located on the taskbar.

4. Minimizing a window and the behaviour, appearance, and manipulation of minimized windows shall be consistent with Microsoft Windows styles.

5. When a window is closed, it shall be removed from the screen and normally its children windows shall be closed.

6. An application shall assign focus to another window in the application (e.g., the parent window) when the application window with input focus is closed.

7. The effect on children windows of closing windows shall be consistent with Microsoft Window styles.

8. Open or minimized windows shall be considered to be active if processing is occurring in the window. Windows do not have to have input focus to be active. A window without input focus may also be active, as long as processing in the window continues. The content of an active window continues to update even if the window loses input focus.

9. The window that receives keyboard events is said to have the input focus and is always open.

10. A window is in the open state when it is on the screen. Multiple windows shall be allowed to be open at any time.

11. A window shall be active when it has input focus.

12. A window shall have input focus when it first appears on the screen if the window was launched in response to a user's request.

13. When a window is minimized, it shall be replaced by a button and any processing that was occurring in the window continues.

14. When a window is closed it shall be removed from the screen and processing that was occurring in the window shall stop. Exceptions include the following: Windows where background processes, message transmission, and database updates are occurring.

15. When a window with input focus is closed, the focus is set to the previous window that had the focus.

Source

CSFAB, TBM, DISA, MSWUE, UCA.

Discussion

G2. This provision was edited for Maritime operations so that no window may completely obscure other windows.

G12. This guidance was amended to ensure that any change in focus is under the control of the user.

15.2.2 Minimized windows

1. A minimized window shall have the same title as its corresponding window.

2. A minimized window title shall be the same width as the minimized window entry; the title may be truncated to fit.

3. When the location cursor appears on the minimized window, the full window title shall be displayed.

4. When the location cursor is not on a minimized window, the title shall be truncated to the same width as the minimized window button.

5. The minimized window menu shall have the same options as the Window Menu for the corresponding window, but not all options shall be available for selection (see MSWUE for details regarding minimized window menu options).

6. To display the minimized window Menu, users shall click the M button (the right button) on the minimized window.

7. To dismiss the minimized window Menu, users shall click the M or S button anywhere outside the menu.

Source

TBM, DISA, MSWUE.

15.3 Window components

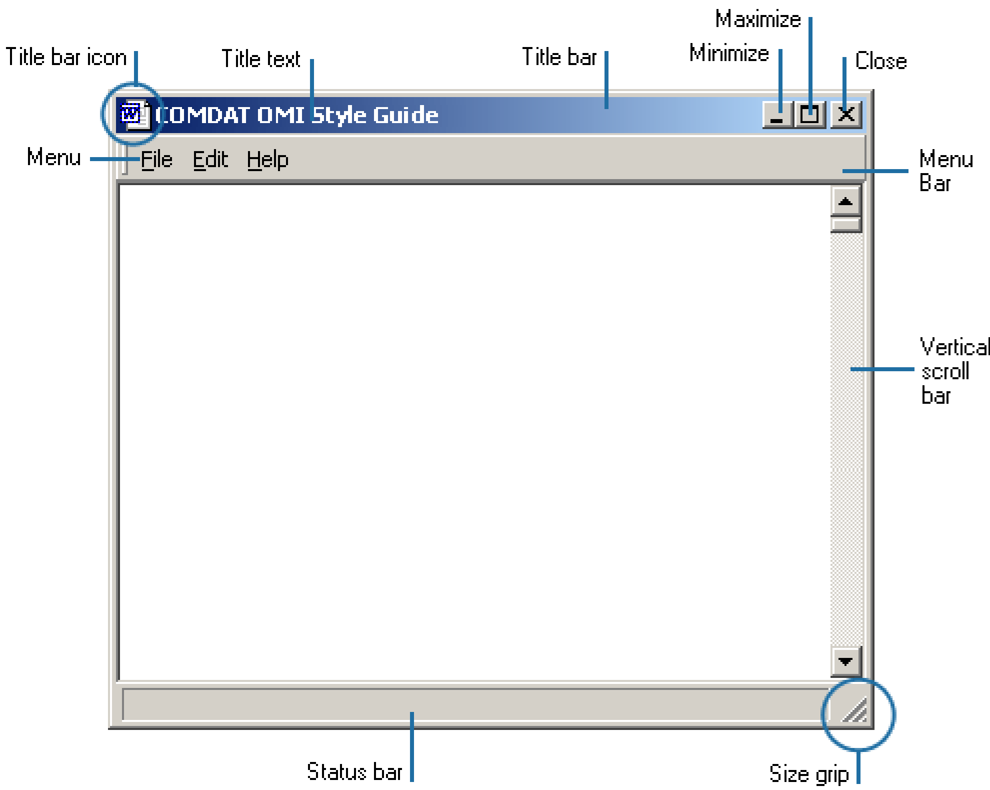


Figure 26: Illustrations of the standard window components (e.g., title bar, window menu, minimize/maximize/close buttons) residing within the primary window as discussed in Sections 15.3.2, 15.3.3, and 15.3.4.

15.3.1 Window component characteristics

1. All windows shall consist of two principle areas: a window frame and an application or client area.

2. The contents of the window frame differ by window type but the frame may contain a title bar, resize border, window menu button, and title bar buttons. The exact function of each object shall be a function of whether the window is a root (system), primary (application), or secondary (file) window.

3. A resize border shall allow the operator to alter the size of the window.

Source

CSFAB, TBM.

15.3.2 Title bar

1. A window title shall appear in the title bar of a window.

2. The title shall be left justified in the title bar and presented in mixed-case letters. The first letter of each significant word in a title and acronyms shall be capitalized (e.g., Office Sym, Exit).

3. If a title is not yet defined a default of Untitled shall be used.

4. The title shall match or at least contain the wording from the icon, menu, button, or other action that invoked the window.

5. Each display shall be labelled with a title or label that is unique within the system. To make the display as meaningful as possible and to reduce user memory requirements, every field or column heading shall be labelled.

6. If an application has multiple primary task windows, each title shall indicate the window purpose and includes the application name separated by a dash (-).

Source

CSFAB, TBM, DISA.

15.3.3 Title bar buttons

1. The Microsoft Windows styles shall be followed for the design and implementation of title bar buttons, controls, icons, and locations.

2. A Minimize button shall reduce the application to its smallest size.

3. For primary windows, minimizing removes the window from the screen and the window shall appear as a button on the taskbar.

4. A Restore/Maximize button shall be a toggle button consistent with the Microsoft Windows styles. The button shall show the Maximize icon and shall enlarge the window to its largest size when selected. If the window is already maximized, the button shall show the Restore icon and shall, when selected, restore the window to its previous size.

5. The order of the shortcut buttons on the title bar shall be in the following order from left to right with the close button in the right-hand edge of the title bar: Minimize, Restore/Maximize, Close.

6. Context-sensitive Help buttons shall be designed and implemented in accordance with Windows styles. When applicable, context-sensitive help buttons are displayed as the left-most button of the shortcut buttons on the title bar.

Source

CSFAB, MSWUE.

15.3.4 Window menu bar

1. If a window includes a menu bar, it shall be located below the title bar.
2. The menu bar shall contain no more than ten menu titles plus Help.
3. The menu titles shall begin at the left margin and extend to the right.
4. Each menu title shall include a mnemonic.
5. Options in application menus shall not duplicate functionality that is available in the system menu.
6. A menu shall have the same title and options when it is in an application menu bar.

Source

TBM, DISA

15.3.5 Window menu button

1. The window menu button shall provide access to a pull-down menu that may contain the following window management options: Restore, Move, Size, Minimize, Maximize, and Close (see Table 5, below, for a table presenting window menu titles and functions).

Table 5: Window menu options and operations

Window Menu	A window menu is used to display a list of window actions. The window menu button is located in the upper-left corner of every window. Pressing the window menu button activates the menu and presents the following options: Restore, Move, Size, Minimize, Maximize, and Close.
Restore	The Restore option restores the minimized or maximized window to the previous size and location.
Move	The Move option moves a window around the workspace.
Size	The Size option changes the height and width of the window in the direction indicated by the pointer.
Minimize	The Minimize option minimizes a window to its smallest size.
Maximize	The Maximize option enlarges a window to its maximum size.

Close	The Close option closes a window and removes it from the workspace.

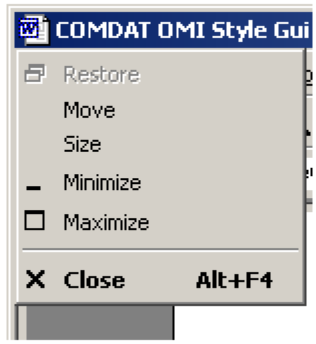


Figure 27: Window pull-down menu.

2. If any of the Window Menu options are not available for a certain window, those options shall be disabled.

3. Additional Window Menu button options may be provided. If so, they shall be placed before the Close options.

4. For fixed windows without title bars, the Window Menu shall contain Window Information as the first option in the menu. This option will provide a window containing all relevant window information that is missing because of the lack of a title bar or message bar in the fixed window.

5. Double clicking on the Window Menu button shall perform the close command.

6. Navigation and selection in the Window Menu shall be done as in a pull-down menu.

7. In addition to using the Window Menu users can execute mnemonics or keyboard accelerators to select manipulation options (see MSWUE for keyboard accelerators).

Source

CSFAB, TBM, MSWUE.

Discussion

OSF/Motif and Microsoft Windows handle window menu functions differently. The differences include how the minimized windows are displayed and the actions taken on them. Developers should consult MSWUE for details regarding the window menu. Throughout this section the sources for the specification are cited, however the specifications have been edited to be consistent with MSWUE.

15.3.6 Optional window properties

1. A message bar is an optional window component that can be used at the discretion of the designer. A message bar is a place to display non-critical application messages. A

message bar shall not be used to display messages requiring immediate action by the operator.

2. A footer bar can be used to display defined function keys, function icons, or application settings information. However, function icons shall be made available in the upper tool bars if space permits.

3. A footer bar is space efficient if a horizontal scroll bar is used. The footer bar can be located to the left of the horizontal scroll bar, as the scroll bar does not require the entire client area width.

4. A pane or separator provides two application areas in one window. This is used to allow the operator to view two different parts of the window simultaneously. The pane or separator divides the application area either vertically or horizontally. Initially the application area is divided in half but the operator shall be able to move the pane to adjust this division.

Source

CSFAB, UCA.

15.4 Windows operations

15.4.1 Moving a window

1. To move a window, users shall select the Move option in Window Menu, and then drag the window to new location. An outline of the window shall move on the screen as the user moves the pointer.

2. To move a window, users shall select the title bar and then drag the window to the new location. An outline of the window shall move on the screen as the user moves the pointer.

3. A window shall not be allowed to be moved to a position such that parts of the window leave the display area.

4. Windows shall be moved between multiple display surfaces by dragging the window from one display to the other.

Source

CSFAB, TBM, MS1472F.

15.4.2 Opening and closing windows

1. When a window is closed and then reopened, it shall be displayed where it was when it was closed.

2. To close a window, users shall select the Close option in the Window Menu or select the Close button and the window shall close. Users shall be prompted to save any unsaved data.

3. Closing a window removes it from the display and ceases all processing in that window. If processing is occurring or unsaved data has been generated, users shall be required to confirm the action before the window is removed from the screen and processing stops.

4. Upon closing a window, automatic saving may be used instead of user confirmation if saving is always desired.

Source

CSFAB, TBM.

15.4.3 Sizing windows

1. To resize a window, users shall select the Size option in the Window Menu, and then drag the frame to the new size. An outline of the window shall move on the screen as the user moves the pointer.

2. To resize a window, users shall press the S or T button when the cursor is over the window frame, and then drag it to the new size. An outline of the window shall move on the screen as the user moves the pointer.

3. When a window is resized, only the window borders (not the size of objects) shall be changed/resized.

4. When a window is resized, the relative position of objects in the window shall not change.

5. The contents of the window shall remain visible during resizing so users can view the effect.

6. Horizontal and vertical scroll bars shall appear as appropriate when a window is resized.

7. Resizing a window smaller is limited to a predefined minimum size so that objects are not obscured when the window is at its minimum size.

8. Resizing a window larger is limited so that the system-level classification and menu bar shall not be obscured by the window at maximum size.

9. All window types shall be capable of being resized larger only if more information can be displayed by resizing.

10. A window will only be permitted to be resized in the direction that displays more information.

11. A dialog window shall not be resized any smaller than its default size.

12. Users shall be able to resize an application window that covers the entire screen.

13. Windows shall be sized so that all objects in it are visible when the window first appears.

14. At a minimum, a window shall be wide enough to read the title and tall enough to read the title and menu bar.

Source

TBM, DISA.

Discussion

G3. Exceptions to this design rule include objects in graphs (e.g., lines, bars, etc.), lists or graphic schedules. As a window is resized, these objects may want to be resized along with the window and lists and text areas.

G4. Exceptions to this design rule include objects in graphs (e.g., lines, bars, etc.) or graphic schedules. As a window is resized, these objects may need to be resized along with the window. Other exceptions might include a window that contains a scrolled list widget where the list is stretched when the window is resized larger.

G10. If a window contains a list widget and more information can be displayed by resizing the window in a vertical direction then the window will not permit the user to resize it larger in a horizontal direction since no new information is displayed in this direction. However, the user shall still be able to make the window smaller.

15.4.4 Restore, minimize, and maximize windows

1. To minimize a window, users shall select the Minimize button on the Title Bar or the Window Menu. The window shall be minimized and, for primary windows, its entry shall appear on the taskbar.

2. To restore a minimized window, users shall click the S button on the entry of the minimized window.

3. To maximize the size of a window, users shall select the Maximize button on the Title Bar or the Window Menu and the window shall expand to its full size.

4. To restore a window to its previous size, users shall select the Restore option in the Window Menu or the Restore button and the window shall be restored to its previous size.

5. The default, maximum, and minimum size of each window shall be defined in the application.

6. When resized, the graphics in the window may remain the same size, or may be rescaled to fit the new window size. This is determined by the task requirements. If the window display is clipped, the upper-left corner information shall remain in the upper-left corner in the newly sized window.

7. A minimum size for a window may be specified. Otherwise, the window shall be tall enough to display the title bar, classification bar, and menu bar. The window shall be wide enough to display the window menu button, window title, and the minimize and maximize buttons.

8. The design may specify a maximum size for a window; otherwise, the maximum size shall be determined by the operational requirements.

Source

CSFAB, TBM, MSWUE.

15.4.5 Window placement

1. A window shall be displayed at the same location where it was when last closed or minimized.

2. Initially, a window shall be placed so important information is at the centre of the users' visual focus.

3. Initially, a window shall be placed so important information is not obscured.

4. Initially, a window shall be placed so the amount of pointer movement to execute an operation is minimized.

5. Initially, a dialog window shall be placed to the right of the information to which it relates.

6. A gradual stepping alignment shall be used to display multiple non-modal dialog boxes that are spawned from an application. This will prevent new dialog boxes from appearing on top of each other. Each dialog box can be located in a position that is slightly downward and to the right.

7. Secondary and dialog windows shall not open initially in a corner of the screen (e.g., top left corner).

8. A default location and size shall be specified for each window when it first appears on the display. The system shall provide the user the option of changing the default to the present size and location. The system shall provide the ability to revert to the system default.

Source

CSFAB, TBM, DISA.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of all windows used in the OMI.

Relationship to other guidelines

10 Windows

11 Window design guidance

12 Windows navigation and selection

16 Security and Simulation

16.1 Security and simulation characteristics

16.1.1 System security

1. Data shall be protected from unauthorized use, potential loss from equipment failure, and user errors.

2. Automated measures shall be provided to minimize data loss from intruders in a system or from errors by legitimate users.

Source

MS1472F.

16.1.2 System simulation

1. When simulated data and system functions are provided real data shall be protected and real system use shall be clearly distinguished from all simulated operations.

2. In applications where either real or simulated data can be displayed, a clear indication of simulated data shall be included.

Source

MS1472F.

Discussion

G2. MS1472F requires that the indication of simulated data shall be displayed as part of the classification label.

16.2 System login

Login windows, (e.g., Figure 28), can be implemented to restrict access to sensitive applications. As a minimum, the login window contains two text fields: one for entering a user name and one for a password. For security purposes, asterisks are displayed for each password character entered.

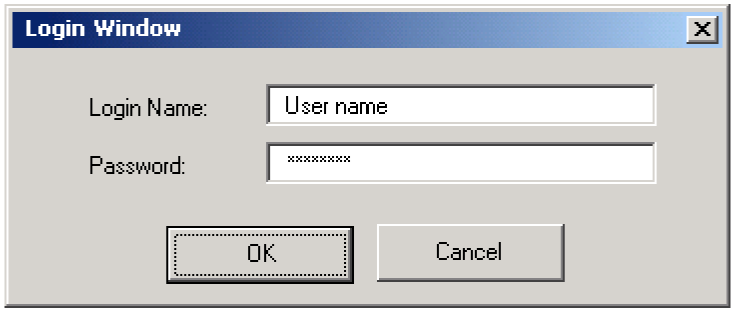


Figure 28: Example of a login window.

1. Where two or more users must have simultaneous access to the computer program or data processing results from multiple personal equipment interfaces, the operation by one person shall not interfere with the operations of another person unless mission survival may be contingent upon pre-emption.

2. Provisions shall be made so that a pre-empted user can resume operations at the point of interference without information loss.

3. Users shall complete a login procedure before the system functions can be accessed.

4. In applications where users must login to the system, login shall be a separate procedure that must be completed before a user is required to select among any operational options.

5. Users shall be provided with feedback relevant to the login procedure; the feedback shall indicate the status of the inputs.

6. A system shall provide access to only those applications to which a user is allowed access.

7. Operators must be able to login in any operational role so as to assume any role within the operations room as required.

8. If appropriate, users shall also complete a login for individual or groups of applications.

9. If the system is unavailable, a message shall be displayed indicating the system status and when the system will be available.

10. If a user cannot login to a system, a prompt shall be provided to explain the reason for this inability.

11. Login processes shall require minimum input from the user consistent with the requirements prohibiting illegal entry.

12. A login window shall be displayed on the screen when users begin a session on a system.

13. Appropriate prompts for login shall be automatically displayed on the user's terminal with no special action required other than turning on the terminal.

14. A login window shall contain two text fields, one each for entering user identification and password.

15. User identification procedures shall be as simple as possible, consistent with adequate data protection.

16. The password shall not be echoed on the display. An asterisk (*) shall be displayed for each character when inputting secure passwords during login.

17. When passwords are required, users shall be allowed to choose their own passwords since a password chosen by a user will generally be easier for that individual to remember. Guidelines for password selection shall be given so that users will not choose easily guessable ones.

18. Users shall be allowed to change passwords whenever they choose; all passwords shall be changed at periodic intervals (not to exceed six months).

19. The text fields shall not provide cues as to the number of characters required for a password.

20. The layout and format of objects in the login window shall have the system title or logo centred at the top. The login name and password fields shall be on two separate lines below the title. The window shall have button controls at the bottom that shall include, at minimum, the Login button in addition to the usual controls.

21. Users shall enter a valid identification and password before a session is initiated.

22. If an invalid identification and/or password is entered, an error message shall be displayed.

23. Users who fail repeatedly to login shall be locked out of the system and informed that they must contact the system administrator.

Source

CSFAB, TBM, DISA, MS1472F, UCA.

Discussion

As much as possible, a login procedure should not be required in Canadian Maritime CCSs for operators. Login procedures may be implemented in order to track training or for record-keeping. Before requiring login procedures to be implemented, the project office should consider the consequences within the operational context. An example of a negative operational consequence is the potential for a delay while an operator performs the login, thus impeding a hot swap.

G17. Before requiring passwords as part of the login procedure, the extent of security measures required should be determined.

16.3 System logout

1. To terminate a session, users shall select logout from the system menu.

2. Users shall be prompted to save data prior to logout if there is any unsaved data.

3. Users shall be prompted to logout of any applications that required they login.

4. During logout, all processing in application windows shall stop, and all windows shall be closed, with the exception of the CCS window.

5. When logout is complete, the initial login window shall be displayed.

6. If there is auto logout, the system shall incorporate the standard length of user inactivity before logout occurs.

7. Users, or the system administrator, shall be permitted to modify the time before auto logout occurs.

8. A message is displayed during inactivity indicating the action needed to avoid auto logout.

9. For auto logout, unsaved data shall be saved, with a message indicating logout and file name.

10. If a partial hardware/software failure occurs, the program shall allow for orderly shutdown and establishment of a checkpoint so restoration can be accomplished without loss of computing performed to date.

Source

TBM, DISA, MS1472F, UCA.

Discussion

G4. The logout procedure normally closes all application windows, even the CCS application. UCA added the caveat that the CCS application shall not be closed upon logout.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of security procedures used in the OMI.

17 Data display and entry

17.1 Data display and entry characteristics

1. The design of each window shall be consistent with the task being performed by users.

2. If push buttons are used in a data entry window, they shall be separate from the main body of the window and shall be located at the bottom of the window.

3. If the data extend across several pages, related data shall be placed on the same page.

4. The format for the data display shall be compatible with the format used for data entry.

5. When users work from a hard copy form, the window format shall have an identical format, unless a tailored soft version is demonstrably more effective.

6. Default values shall be used to reduce user workload. Defined default values shall be displayed automatically in their appropriate data fields with the initiation of a data entry transaction and the user shall indicate acceptance of the default.

7. The user shall be able to replace any default value during a given transaction without changing the default definition.

8. Where a series of default values have been defined for a data entry sequence, the experienced user shall be allowed to default all entries or to default until the next required entry.

9. Field labels shall be distinctively presented such that they can be distinguished from data entry. Labels for data entry fields shall incorporate additional cueing of data format where the entry is made up of multiple inputs.

Source

TBM, MS1472F.

17.2 Data entry and manipulation

17.2.1 Data entry and manipulation characteristics

1. Data entry shall be consistent with the Microsoft Windows styles.

2. A data entry window shall include a title that describes the contents of the window.

3. Display formats shall be consistent within a system. When appropriate for users, the same format shall be used for input and output. Data entry formats shall match the source document formats.

4. Data entry functions shall be designed to establish consistency of data entry transactions, minimize input actions and memory load on the user, ensure compatibility of data entry with data display, and provide flexibility of user control of data entry.

5. Data entry shall be paced by the user, rather than by the system.

6. The same set of actions to enter and manipulate data shall be used throughout the application.

7. The system shall provide a positive feedback to the user of the acceptance or rejection of entered data, if appropriate.

8. Feedback shall be provided which presents status information, confirmation, and verification throughout the interaction.

9. If the system rejects a user input, feedback shall be provided to indicate the reason for rejection and the required corrective action. Feedback shall be self-explanatory.

10. Editing commands such as Cut, Copy, and Paste shall be available if these commands shall facilitate the text entry process.

11. The default for text entry shall be insert mode.

12. When variable length information is entered in a text field, it shall be automatically justified. Text shall be left justified. Numeric data shall be justified on virtual or literal decimals.

13. Leading characters shall not be required to fill data entry space. For example, if a text field has a maximum length of four characters and the user wants to enter the number 900, the system shall not require the user to enter 0900. The leading character of 0 shall not be required (except as necessary for compass headings or similar conventions).

14. Users shall be able to enter numeric data via the keyboard and the numeric keypad.

15. Users shall not have to enter the unit of measurement associated with a numeric value.

16. Data shall be entered in units that are familiar to the user.

17. When multiple data items are entered as a single transaction, the user shall be allowed to re-enter, change, or cancel any item before taking a final enter action.

18. When users finish making entries in the appropriate data fields in a window, they shall enter the data into the system with an explicit action such as selecting a save option.

19. A data entry window shall contain the controls needed to support data entry and manipulation.

20. If users have to make multiple entries, the data entry window shall include controls to clear the window and restart the data entry.

21. Dialogue types (e.g., form filling, menus) shall be compatible with anticipated task requirements and user skills.

22. Groups of data shall be displayed vertically, not horizontally, although columns may be used.

23. If information being entered in a text field is a known fixed length, the text field shall be the same length.

24. If the length of information being entered in a text field varies, the text field shall be as long as the longest possible entry.

25. A text field may include scroll bars if space in the window is limited.

26. The text field shall include a decimal point if numeric data are entered in decimal format.

27. Field formats shall be consistent with users' expectations and presented in meaningful chunks.

28. Data that are known or can be computed shall be automatically entered in a field.

29. Data shall not be entered by overwriting a set of characters in a field (such as a default).

30. When an item length is variable, the user shall not have to remove unused underscores.

31. Data entry fields that do require the operator to enter non-word character strings over four characters shall be divided into equal segments of no more than four characters each. If possible the groups shall be equal in size and have meaning (e.g., time HH:MM:SS).

32. Routine or default data shall be automatically entered in a field. If this data could produce a detrimental effect, it shall not be automatically entered or must be confirmed by the operator.

33. Where no source document or external information is involved, forms shall be designed so that data items are ordered in a logical sequence for input.

34. Form filling interactive control may be used where some flexibility in data to be entered is needed and where the users will have moderate training. A form-filling dialogue shall not be used when the system must handle multiple types of forms and the system response is slow.

35. Displayed forms shall be arranged to group related items together.

36. The capability shall be provided to label and store frequently used text segments, forms, and templates (e.g., signature blocks, organizational names, call signs, coordinates), and later to recall (copy into current text) stored segments identified by their assigned labels.

37. Actions that affect the items on the situation display (or tactical display) shall provide visual feedback to the operator that the action was completed as intended.

38. When operators access information in order to alter the data, the window shall initially show the current state of the information.

39. Data entry shall be supported by standard widgets that facilitate data entry and avoid keyboard entry by the operators. Examples include widgets such as spin boxes for numbers and calendars for dates.

40. Widgets implemented to support data entry (e.g., spin boxes for numbers and calendars for dates) shall not replace the manual entry of data.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE, UCA.

17.2.2 Pointer control

1. The text pointer shall be placed and moved with both the pointing device and the keyboard.

2. When a window has input focus, the text pointer shall appear in the text area where the typing is most likely to occur.

3. When the Select button is clicked in an empty text field, the text pointer shall appear at the first character space in the text field and the pointer shall remain displayed in insert mode.

4. The pointer shall disappear from the screen when users begin typing and shall reappear when users stop typing or move the pointing device.

5. The pointer shall be an I-beam shape only when users move the pointer into a text field where text entry is possible.

6. The text pointer shall only be allowed to be placed in areas where text entry is possible.

7. Text entry shall not be possible when the text pointer is not visible and shall only be possible when the text pointer is visible.

8. Applications shall ensure that the text pointer is highly visible when it appears in a text entry area.

9. When the pointer is on non-editable text, its shape shall not change to an I-beam.

10. Clicking on non-editable text shall not change its appearance or display a text pointer.

Source

TBM, DISA, MS1472F.

17.2.3 Navigation

1. Users shall move the text cursor between single line text fields by pressing <TAB>.

2. Applications shall not automatically tab to the next field.

3. When the text pointer is tabbed into an empty text field, the text pointer shall appear in the first character space at the left end of the text field.

4. Users shall also be able to place the text pointer at any location within the text in a text field by positioning the pointer and pressing the Select button.

5. The size of the text pointer shall change to match the size of the text font in which it is placed.

6. In a multi-lined text field, the arrow keys on the keyboard shall move the text one increment (i.e., one line or one character) in the specified direction.

7. In a multi-lined text field, <Ctrl> in combination with the arrow keys shall move one large increment (i.e., one word or one paragraph) in the specified direction.

8. In a multi-lined text field, <Home> and <End> shall move the text cursor to the beginning and end of a line.

9. In a multi-lined text field, <Ctrl> + <Home> and <Ctrl> + <End> shall move the text cursor to the beginning and end of the text file.

10. If multi-line text is in a window with a default action, <Enter> or <Ctrl> + <Return> shall execute the default action.

11. In a multi-lined text field, <Return> shall insert a carriage return.

12. In a single-lined text field, the arrow keys on the keyboard shall navigate to a different component.

13. In a single-lined text field, <Ctrl> in combination with the arrow keys shall move one large increment (i.e., one word or one paragraph) in the specified direction.

14. Users shall be provided the capability to back up to any text field and edit the entry prior to entering data into the system.

15. Selecting a text field with the pointer shall make that the focused or active field and place the cursor at the beginning of the text field. The entire field may be selected upon initial entry if desired by the designer.

16. A displayed pointer shall be positioned by the system at the first data entry field when the form is displayed. The cursor shall be advanced by a tab key to the next data entry field when the user has completed entry of the current field or shall automatically move to the next field when the end of the field is reached. The default value for the automatic movement of the cursor shall be off.

Source

CSFAB, TBM, MS1472F.

Discussion

G2. Automatic tabbing shall be restricted to situations where data entry occurs in fixed-length entries. Developers shall not combine auto tabbed and manually tabbed fields in the same data entry window.

G3. This occurs only if the text field is empty. If there is existing data in the field, then the pointer tabs to its previous location the last time the field was active.

17.2.4 Manipulation

1. Users shall be provided the capability to easily specify the format of a document and the font type, size, and style.

2. Automatic line break and word-wrap at the right margin shall be available.

3. Automatic pagination (page numbers based on the number entered by users) shall be available.

4. The window shall be formatted as the printed output, or an option to see this format shall be provided.

5. A copy of the original document shall be retained until users confirm that it is to be changed.

6. The original document shall not be modified automatically as users make each editing change.

7. Applications shall provide both Find and Find and Replace capabilities for users. The Find and Find and Replace capability shall be in accordance with the design guidance in MSWUE styles. In a Find capability, users shall type the text string (case-sensitivity shall be optional) and the first instance is highlighted. In the Find and Replace capability, users shall type the text string and the first instance is highlighted or if requested a global replace-all capability shall make all the changes requested.

8. Where text formats are a user option, a convenient means shall be provided to allow the user to specify and store for future use the formats that have been generated for particular applications.

Source

TBM, MS1472F

17.3 Data display

17.3.1 Data display characteristics

1. Multi-coloured text shall not be used as a code to sort data.

2. Multiple colour-codes shall not be used unless the colours are already associated with specific meanings.

3. Every third or fifth row of data shall be separated by a delimiter. The delimiter may include light background shading in groups of three to five rows (similar to old-fashioned computer paper), separator lines, or other means consistent with the application.

4. Information shall be automatically justified.

5. Justification rules shall be followed: left-justify alphabetic data; right-justify integers; justify decimal data on the decimal point.

6. When five or more alphanumeric characters without natural organization are displayed, the characters shall be grouped in blocks of three to five characters within each group separated by a minimum of one blank space or other separating character such as a hyphen or slash.

7. Descriptive wording shall be employed when labelling data fields; use of arbitrary codes shall be avoided.

8. The ordering and layout of corresponding fields shall be consistent and have the same names.

9. Users shall not be required to translate feedback messages by use of reference system or code sheets. Abbreviations shall be avoided.

10. Only data essential to the user's needs shall be displayed.

11. Data presented to the user shall be in a readily usable and readable form such that the user does not have to transpose, compute, interpolate or mentally translate into other units, number bases, or languages.

12. A text window shall be wide enough to display an entire line of text without scrolling. Text windows shall be no wider than 40-60 characters.

13. Text fields that represent real data shall be distinguishable from text fields that represent test or simulated data.

14. If a specific format is required, an example of that format or an example entry shall be displayed.

15. Text fields that require certain text formatting shall provide this formatting automatically (e.g., convert small case to CAPS where required).

16. The operator shall be given visual cues for unacceptable entries, required entries, and the location of the present entry field.

17. Once an entry has been made, the operator shall not have to re-enter this information but rather it shall be selectable (e.g., once the operator enters a name the name can be selected from an option menu or list box).

18. A name entered into an option menu or list box shall be able to be deleted at the request of the user.

19. Operators shall not have to memorize codes for objects with commonly known names unless the code is also commonly known by both novice and experienced users (e.g., do not have a code for selecting a certain missile, instead use that missile's name and have the system provide the required codes).

20. The user shall not have to rely on memory to interpret new data; each data display shall provide needed context, including recapitulating prior data from prior displays as necessary.

21. The user shall not be required to learn mnemonics, codes, special or long sequences, or special instructions.

Source

CSFAB, TBM, MS1472F, UCA.

Discussion

G1. CSFAB states that multi-coloured text shall be used when it provides additional meaning that can not be achieved by sorting; however, multi-coloured text is difficult to read and should not be used. Colour coding can instead be achieved by coloured backgrounds, or familiar colour codes placed next to the items to be grouped.

17.3.2 Organization

1. Data fields shall be organized by sequence of use, frequency of use, or importance.

2. Displayed data items that are critical or require immediate user response shall be grouped at the top of the display.

3. Sets of data that are associated with specific questions or related to particular functions shall be grouped together to signify those functional relationships.

4. Data items used more frequently than others may be grouped at the top of the display.

5. Data fields shall be organized with related fields together and unrelated fields separated.

6. Data fields to be compared on a character-by-character basis shall be positioned one above the other with alignment of characters to be compared.

7. Users shall be able to obtain information about a data field and its contents.

8. Data field names shall be unique; the same names shall be applied throughout the application.

9. Required data entry text fields shall be distinguishable from optional data entry text fields.

10. Data fields with values that cannot be changed shall be displayed in a read-only information area.

11. Location of recurring data shall be similar among all data displayed and common throughout the system.

12. Long strings of numbers shall be delimited with spaces, commas, or slashes (not leading zeros).

13. Strings of alphanumerics shall be grouped into sets of three to five characters or grouped at natural breaks. When a code consists of both letters and digits, common character types shall be grouped by common character type for ease of location.

14. If a data record extends beyond a line and the entire line of data must be displayed at all times, each line beyond the first line shall be identified as a continuation of the record.

15. If a data record extends beyond a line and the entire line of data does not need to be displayed at all times, a method shall be designed so that users can select an individual data record and view all the data fields available for that record.

16. Information shall be presented (or requested) only to an operationally valid level of detail (tactical significance); unnecessary detail shall be removed from the display.

Source

TBM, DISA, MS1472F, UCA.

Discussion

G16. This item was added as a result of the review of the COMDAT TD.

17.3.3 Text

1. It is essential for successful operations that text displayed to the operators shall be legible and readable under operational lighting conditions and at over-the-shoulder viewing distances.

2. Legibility refers to the identification of single characters and is a function of letter height, stroke width, height to width ratio, contrast ratio, and polarity. If standard fonts are used, character height is the most important factor when designing so that the characters are legible. Characters shall be legible.

3. Readability is the ability to recognize groups of letters or words that have contextual meaning. If the letter, word, or line spacing of text is too close, user will have trouble recognizing words. If the spacing is too large, reading performance will slow. The text line length also determines the speed and ease of reading. Contextual text shall be readable.

4. Normal, dimmed, and highlighted text shall appear and behave as indicated in MSWUE.

5. Black shall be used for text in windows.

6. Fully saturated blue text shall not be used as it is difficult to perceive.

7. White text shall not be used on black backgrounds as irradiation causes characters to spread out and lose sharpness.

8. Light text on dark backgrounds may require slightly less stroke width than dark text on light backgrounds. This is due to irradiation, which is a phenomenon that causes white features on a black background to appear to spread out. Any polarity advantages seem to lean toward dark text on light backgrounds.

9. Either the characters or the background shall produce a minimum luminance level of $35cd/m^2$ (10 foot-lamberts).

10. The text to background contrast ratio shall be a minimum of 1.5:1 for disabled text and 3:1 for normal text. Contrast ratios of 7:1 to 20:1 or more are preferred.

11. Smaller character heights and stroke widths shall be designed with higher contrast ratios to maintain the same perceptibility as larger letters. For example, letters of 10 minutes of arc would need a contrast ratio of 19:1 to provide the same legibility as letters of 20 minutes of arc with a 3:1 (1.86:1) contrast ratio (equivalent contrast ratio formulas).

12. If text is other than black, the text colour shall have sufficient contrast with background to be readable.

13. Sans serif fonts shall be used for all text displayed.

14. Use a font equivalent to the windows appearance of MS® San Serif or Tahoma for displaying system generated text in sentence format and labels.

15. The title bar text shall use the bold setting equivalent of the basic system font chosen.

16. Except for title bars, bold or italic fonts shall not be used for interface text.

17. Bold text shall be used in menus to indicate that a command is a default action.

18. The text in each window shall be of sufficient size to be legible by users when they are at an over-the-shoulder viewing distance from the screen.

19. The minimum font size shall subtend 10 minutes of visual arc at the longest viewing distance. The minimum font size for text that requires rapid readability is 16 minutes of visual arc with a preferred size of 20-22 minutes of visual arc.

20. For reading lines of text, the maximum font shall be 24 minutes of visual arc. Font heights greater than 24 minutes of visual arc shall only be used for titles or labels consisting of single words or short phases.

21. Minimum, preferred, and maximum character heights at a minimal over-the-shoulder viewing distance are respectively 0.13, 0.16, and 0.19 inches. The OMI shall be designed for the minimum over-the-shoulder viewing distance (27 inches).

22. Text character height shall be 1/200th of the viewing distance.

23. Text character width shall be 50-100 percent of character height.

24. The text character stroke width minimum shall be 10-12.5 percent of character height.

25. Spacing requires one stroke width minimum between all characters and a maximum spacing of one average character width. Spacing between words requires an average character width. Spacing between lines shall normally be the height of an uppercase character but may be reduced to the height of a lowercase letter if space is at a premium.

26. Text characters shall contain a minimum 7 X 9 dot matrix construction.

27. Text used for briefing presentations shall use at minimum a 10 X 14 dot matrix format, double stroke width.

28. Applications with word processing capabilities shall provide a choice of fonts as a user-selectable option.

29. The character stroke width of a system font shall be at least 2 pixels in thickness.

30. The selected font style shall be legible in various display resolutions from 72 pixels per inch to 120 pixels per inch.

31. User font cells shall be the same height as the system fonts that will be used with them. The glyphs within the character cell for a user font shall be positioned at the same location and have the same height as those for the associated system fonts.

32. Fixed width fonts shall be used for text field widgets receiving data entry and for system generated non-editable text fields.

33. Consistent grammatical structure shall be used for all non-editable text in windows.

34. Wording shall be consistent and use familiar terms and task-oriented language of users.

35. Blocks of text shall be broken into smaller, meaningful groups.

36. Continuous text shall be phrased in simple sentences, in the affirmative, and in active voice.

37. A sequence of events or steps shall be presented in the order the steps are performed.

38. The referent for *it* or *they* in a sentence shall be easily identified.

39. Normal punctuation rules shall be followed, and contractions and hyphenation shall be avoided.

40. Editable text shall be displayed in upper/lowercase as appropriate to the task being performed.

41. Stored text shall be shown in standard format; text editing is converted into the standard format.

42. All labels, text, titles, acronyms, words and headings shall be spelled correctly.

43. All terms shall be used consistently throughout the OMI. Examples include underlying definitions such as “best quality” from different sensors for local and fused data, terms such as “Platform”, and actions such as “clear alarms”.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE, UCA.

Discussion

Two lighting conditions are used in the Halifax-class control room. These lighting conditions are the following:

- Normal operations room lighting (dim lighting)
- Dark adaptation conditions (red lighting)

The provisions for text size and contrast in this section were developed for operations under normal office lighting. Because visual acuity is reduced under sub-optimal room lighting, the provisions are under-specified for use in the Halifax-class control room. These provisions may require adjustment and should be considered to be minimum starting points for design. To ensure that the text is appropriate at the over-the-shoulder viewing distance, and appropriate under the ambient lighting conditions, all of the design solutions should be validated and tested under the expected operational conditions.

G12. Nearly all text is black with the exception of white (or off-white) letters on very dark backgrounds.

G18. The CSFAB requirement is that the text shall be legible at a normal viewing distance. This Guide requires that the text be legible at the minimum over-the-shoulder viewing distance (i.e., 27 inches). This more conservative specification benefits both over-the-shoulder viewing and the seated operator.

G19. The calculation of visual angle, in minutes of arc, for a given character size (height or width) is:

$$\text{Visual angle} = 60 * \arctan(\text{ size / distance})$$

where the units for size of the character and distance from the screen to the user are the same.

G21. The calculation of character height for a given visual angle, in minutes of arc, is:

$$\text{Size} = \tan(\text{minutes of arc}/60) * \text{distance}$$

where the units for size of the character and distance from the screen to the user are the same.

G22. For example, a viewing distance of 36 inches requires a .18 inch character height.

G42. This guideline and the next one were added as a result of the review of the COMDAT TD.

17.3.4 Labels

1. Colons shall be included when static text is used to label another control.

2. The baselines of text labels shall be aligned with the baselines of the text boxes.

3. The presence and location of control input data entered by the user shall be clearly and appropriately indicated. Data displayed shall not mislead the user with regard to nomenclature, units of measure, sequence of task steps, or time phasing.

4. The label shall be followed by a colon and two spaces before the text (Label: [space][space]text).

5. If a label pertains to a group of text, this group of text shall be offset from the rest of the text by an outline or spacing. If an outline box, or separator line, is used, the label shall be integral with the outline box or separator line.

6. Labels shall be simple, concise words or phrases in terms familiar to the operator.

7. Labels for push buttons, pull-down menu selection, or any other items that perform an action shall be verbs. Labels for radio buttons, checkboxes, lists or any items that present options shall be nouns. Labels for groups of components shall be nouns. See MSWUE for examples of noun/verb and label combinations.

8. If a unit of measurement is always used, it shall be part of the label and does not have to be entered.

9. If text field labels appear to the left of their text fields, text field labels shall use a colon (:) to separate the label from the text field.

10. The label for a text field shall not display a shadow.

11. Text labels of more than one word shall not be run together, nor shall they be separated by an underscore, or any delimiters other than a single space.

12. Required data entry text fields shall be distinguishable from optional data entry text fields. A colour-coded one-pixel border may be placed around a text field. By limiting the border resource to one pixel, it will not interfere with the highlight border. The presence or absence of the border may be used to distinguish required or optional data.

13. A text field label shall appear to the left or above the text field and describes what is to be entered or what is to be displayed.

14. A text field label of a text field shall include cues regarding expected format of the entry.

15. Text field labels shall have the same background colour as the window on which they appear.

16. Labels shall be consistently located adjacent to (and preferably above or to the left of) the data group or message they describe.

17. Labels shall be unambiguously related to the group, field, or message they describe.

18. Labels shall be visually distinct from other text and the accentuating technique shall be different and easily distinguished from the method used to highlight or code emergency or critical messages.

19. Labels shall be unique and meaningful to distinguish them from data, error messages, or other alphanumerics.

20. Each text field, editable or non-editable, shall have a label located to the top or left of the field.

21. When data-entry fields are very long the label may be placed above the left edge of the field.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE, Handbook 5.

17.3.5 Justification

1. All standard text and columns of text shall be left justified. All lines of text shall be wrapped to fit in the provided text window even if this window is resized. This eliminates the need for the operator to horizontal-scroll through text.

2. Tabular data and tables shall not be wrapped. Vertical scrolling shall be used to access text not displayed in the text window.

3. An automatic word wrap (carriage return) shall be provided when the text reaches the right margin for entry/editing of unformatted text. User override shall be provided.

4. Numeric data without decimals shall be right justified. Numeric data with decimals shall be justified on the decimal point.

5. Labels in columns shall be left justified with the associated alphanumeric text being left justified after the longest label. Labels shall be positioned to read left to right and/or top to bottom. Labels shall be of approximately equal length to facilitate associating the label with the text field.

Source

CSFAB, MS1472F.

17.3.6 Leading zeroes

1. Leading zeros shall not be displayed unless required for clarity. However, leading zeros may be displayed during data input to ensure the user did not accidentally leave out a digit.

2. Leading zeros shall be displayed for headings, bearings, and other compass references normally displayed in three digit groups.

Source

CSFAB, UCA.

17.3.7 Numbers

1. When displaying numbers the number zero shall have a slash through it so it is not confused with a capital "O". The letter L and the digit 1 shall also be displayed so as not to be confused with each other.

2. Error checking shall be provided so that letters are not permitted in fields specifically designated for numbers and vice versa.

3. If numbers are rounded or estimated, the rounding shall be done by the system and visually displayed for the operator to see.

4. Numbers shall only be rounded to the level of tactical significance.

5. Any computations using rounded or estimated numbers shall display the answer in the appropriate number of significant digits.

6. Numbers in columns shall be justified on the virtual or actual decimal.

7. Graphic presentation aids interpretation. When graphic presentation of numbers positively impacts operational effectiveness, numbers shall be presented graphically.

8. For small numbers the graphic shall be a one-to-one representation of the numbers.

9. For large numbers, the graphic shall be a summary of the relevant information.

10. Values of zero shall not be left blank but shall instead be presented as zeros. Missing or unknown values shall not be left blank but instead shall be displayed with place markers such as periods or dashes.

Source

CSFAB, MSWUE, UCA.

Discussion

The last two guidelines were added as a result of the review of the COMDAT TD.

G8. For example, since the Halifax-Class carries a maximum of eight Sea Sparrow missiles, the number of missiles remaining and fired can be presented as individual symbols (such as icons or geometric shapes) depicting each missile and missing missile. The number should also be presented in numerals so that the operators do not have to count.

G9. A progress bar showing the time remaining is an excellent example. The progress bar gives at-a-glance information as to how far along the process is (in the example of ammunition, it would give a rough idea of how much ammunition is used and remaining). The graphics shall be supported with specific numbers so that the operator can report the precise values as required.

17.3.8 Units of measurement

1. If the field is associated with a standard and consistent dimension (e.g., feet) then this dimension shall be provided by the system and listed to the right of the field.

2. If a finite number of dimensions are associated with the field then the possible dimensions, as an option menu, shall be provided and presented to the right of the field.

3. If a multitude of dimensions are possible, use another text field (or a menu) for the input of the dimension.

4. Any text that requires a unit of measure shall be immediately followed by either the proper unit of measure or a control to select a unit of measure.

5. The system shall allow users to input data in a familiar unit of measure.

6. The units of displayed data shall be consistently included in the displayed labels.

Source

CSFAB, MS1472F.

17.3.9 Capitalization

1. Titles and major headings shall be presented in book title case.

2. Use of all uppercase letters shall be reserved for acronyms and security classification banners.

3. Arabic rather than Roman numerals shall be used when information has to be numbered.

4. When numeric data is displayed or required for control input, such data shall be in the decimal, rather than binary, octal, hexadecimal or other number system.

5. All sentences and lines of text shall be presented in a combination of upper and lower-case letters, following standard capitalization rules. Mixed case type is recommended as it results in faster word recognition, especially in sentences.

6. Any displayed message or datum selected as an option or input to the system shall be highlighted to indicate acknowledgment by the system.

Source

CSFAB, TBM, MS1472F.

17.3.10 Acronyms and abbreviations

1. An acronym in an application shall be used to denote only one meaning. Acronyms shall not be created when existing acronyms are already defined.

2. Acronyms and abbreviations shall be used only if shorter than the full name and only if understood by users.

3. Abbreviations shall be the shortest possible length that will ensure uniqueness.

4. Abbreviations shall be meaningful, recognizable, and used consistently.

5. Words not commonly abbreviated by the operators shall not be abbreviated.

6. A dictionary shall be available (e.g., in Help) for decoding abbreviations and acronyms.

Source

CSFAB, TBM, MS1472F.

17.3.11 Tables

1. Tabular data windows shall be used for information display only.

2. Where items in a list are displayed in multiple columns, the items shall be ordered vertically within each column.

3. Each column shall have a heading and be clearly separated from other columns by spaces (minimum of 4 spaces) and/or lines.

4. Tables shall provide sorting on all sortable columns through the column heading.

5. When selected, the sorting control on the heading shall indicate the column that was sorted and the direction in which it is sorted.

6. If multiple sorts are required use check boxes in a table; a non-editable field shall be provided to display the order of the sort criteria. Column labels shall be placed in the non-editable field in the order in which the column label check boxes or push buttons were chosen. When a column label check box or push button is de-selected, the label shall be removed from the sort-order field.

7. Where items in a list are displayed in multiple columns then selecting an individual item in one column shall also select the data in the corresponding line of all the columns.

8. If there are multiple pages in a table, the row and column labels shall remain visible along the edges of the page.

9. The widths of columns containing the same data elements shall be uniform and consistent within a table and from one table to another.

10. Tabular displays shall not extend over more than one page horizontally.

11. Tables shall be scrollable by means of one scroll bar that is located on the right side of the right-most column.

12. The width of each column shall at a minimum be the same width as the column label.

13. If the width of the longest data element in a list is unknown or is variable, horizontal scroll bars shall be used for individual columned lists. However, horizontal scroll bars shall only be displayed when needed.

14. Column labels shall be identical for all pages; the last line on a page is the first line on the next page.

15. Tables shall be arranged to show similarities, differences, trends, or relationships. Depending on the task, data may be arranged in sequential, spatial, alphabetical, functional and/or chronological order.

16. Data that are important, require immediate response, and/or are frequently used, shall appear at the top of the table.

17. Rows and columns shall be labelled distinctively.

18. Tabular data shall be displayed in rows and columns. If the data in the rows have an order, the order shall increase from left to right. If the data in the columns have an order, the order shall increase from top to bottom.

19. Tabular data displays shall be used to present row-column data to aid detailed comparison of ordered sets of data.

20. Tables or other displays that contain similar data shall be easily visually distinguished by the operators.

Source

CSFAB, TBM, MS1472F, MSWUE, UCA.

17.3.12 Multiple pages

1. If possible, related data fields shall appear on the same page.

2. When a display contains too much data for presentation in a single frame, the data shall be partitioned into separately displayable pages.

3. If there are multiple pages, each page shall have the same title, current page, and total pages indicator.

4. When partitioning displays into multiple pages, functionally related data items shall be displayed together on one page.

5. The numbering of items shall be continuous from one page to the next. For example, if the last numbered item on page 1 is 8 then the first numbered item on page 2 is 9.

6. If a data window has more than one page, the window includes paging controls.

Source

TBM, MS1472F.

17.3.13 Data query

1. The data query language provided to the users shall reflect the structure of the data as perceived by the users.

2. The language shall allow the users to specify the data to retrieve then display and manipulate it.

3. Users shall be provided the capability to request data without having to tell the system how to find it.

4. Queries shall use operationally meaningful terminology that does not reflect how the data are stored.

5. Users may construct simple and complex queries, create predefined queries, and save, retrieve, and execute these queries.

6. The language shall permit alternate forms of the same query using natural language.

7. Users shall be prompted to confirm a query if data retrieval time will be excessive.

Source

TBM, DISA.

17.4 Data validation and error checking

1. A validity check shall be done on data entered, with visual error messages.

2. Syntactic error checking shall occur immediately upon leaving a data entry field.

3. Users shall be notified of syntactic errors in a standard message area or error message window.

4. Semantic error checking shall occur as soon as is possible. If semantic error checking occurs upon leaving a field, users shall be informed of the error and be provided the capability to revert the collection of data entry fields (form, database record, etc.) to its previous state. If semantic error checking occurs when an entire form or record is submitted as a collection, the user shall be provided with the capability to correct the individual fields in error before again submitting the collection of data entry fields. Due to the increased potential for user error with field-by-field data entry, it is recommended that data entry and semantic error checking be accomplished on a record-by-record basis.

5. Data entries shall be validated by the system for correct format, legal value, or range of values. Where repetitive entry of data sets is required, data validation for each set shall be completed before another transaction can begin.

6. Users shall not be prevented from leaving a field with an error with it. Rather, they shall be allowed to fix the error at their own pace.

7. When required data entries have not been entered, the omission shall be indicated to the user and either immediate or delayed input of the missing items shall be allowed. Delayed entry shall be avoided; however, if it is necessary, the user shall be required to designate the field to indicate that the missing item is delayed, not overlooked.

Source

TBM, MS1472F.

Discussion

Syntactic error checking is done to be sure that data are entered in the correct format. This includes that the correct numeric data falls within minimum and maximum range requirements and that alphanumeric data is recognizable by the system. Alphanumeric data may include abbreviations and acronyms that must be in the proper format.

Semantic error checking is done to ensure that the meaning or context of information entered is correct. This means that one data entry field must be compared against another field. For example, an error should result if a crew has been assigned to a non-existent aircraft tail number. Detecting this type of error requires semantic error checking.

G1. The requirement has been edited to remove the option for auditory error messages because auditory error messages are disruptive and are not conducive to the operations room environment. Note that this guideline does not address operational auditory alerts that may be appropriate.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of all data display and entry functions in the OMI.

Operator performance:

- Objective assessment of use and usefulness of data display and entry functions.

Operator acceptance:

- Subjective assessment of the adequacy of the operator’s perceptions of usability and utility of data display and entry functions in the OMI and ESS.

18 Special functions and formats

18.1 Audible alerts and flash coding

1. Audible alerts shall be avoided unless the alarm provides an alert to a critical situation, requiring an operator's response, that would otherwise be missed, and that the operator would not be otherwise be aware (via voice or radio communication).

2. Non-critical auditory alarms shall not be implemented.

3. When alarm signals are established based on user-defined logic, users shall be permitted to obtain status information concerning current alarm settings, in terms of dimensions (variables) covered and values (categories) established as critical. Alarm status information shall be provided in monitoring situations where responsibility may be shifted from one user to another as in changes of shift.

4. Auditory signals shall be intermittent in nature and allow sufficient time to respond.

5. Auditory signals shall be distinctive in intensity and pitch and shall not exceed two auditory signals.

6. Audio signals used in conjunction with visual displays shall be supplementary to the visual signals and shall be used to alert and direct the user's attention to the appropriate visual display.

7. Flash coding is used only to display urgent information for user attention. Flashing symbols shall require immediate attention that supersedes all other tasks.

8. Only two levels of flash coding, flashing and not flashing, shall be used. Flashing symbols shall be displayed with a flash rate of 3-5 Hz with equal duration of on and off cycles. To avoid losing the object, objects shall flash between two intensity levels, bright and dim not on and off.

9. A maximum of 5 symbols shall be flashing at any one time.

10. The operator shall be provided a means to turn the flashing off and/or the flashing shall only last for a specified duration.

11. A flashing symbol may be used for flash coding. A text item shall not be flashed.

12. Users shall be able to acknowledge the event causing the flash coding and suppress the flash if desired.

Source

CSFAB, TBM, MS1472F.

Discussion

Within the operational context an excess of audible alerts is known to contribute to information overload and negatively impact performance. It is usual for operators to turn off all audible alarms.

G2. The requirement was edited from the requirement, “For non-critical auditory alarms, a simple action acknowledges/turns off the signal.”

G5. Auditory signals tend to be over-used in CCSs. The requirement for an auditory signal shall be considered within the entire operational context and shall be used rarely. UCA reduced the number of auditory signals from four to two because audible codes have no intrinsic meaning to the operators.

G8. TBM permit two levels of flash rate; the second level is defined as less than 2 Hz with equal on/off times.

18.2 Date/time and latitude/longitude

1. All dates shall be presented to and supplied by the operator in the DD MMM YY (10 MAY 68) format. The characters of the month shall be capitalized. The spaces between day and month and month and year may be omitted. If the day or year is a single digit it must be preceded by a zero. The notation 01JAN00 would mean January 1, 2000.

2. Time shall be presented to and supplied by the operator in the HH:MM:SSZ (09:38:30Z) format. HH is the hour in a 24-hour day, MM is the minute with a leading zero if necessary, and SS is the second with the leading zero if necessary. Z is the time zone with Zulu time as the default. The seconds are optional. All colons are required and the Zulu (Z) shall be capitalized.

3. The display shall include Zulu time and local time; Zulu time shall be presented above local time.

4. The date time group shall be presented on the status bar on the right-hand edge.

5. If the operator must know the time in multiple time zones, the application shall provide a separate time for each zone or provide the operator the ability to change the time zone displayed.

6. A date time group shall be presented to and supplied by the operator in the DD HH:MM:SSZ MMM YY format (seconds are optional) where DD is the day with the leading zero if necessary, HH is the hour with a leading zero if necessary, MM is the minute with a leading zero if necessary, SS is the second with a leading zero if necessary, and Z is the time zone with Zulu as the default with MMM as the abbreviated month and YY is the last two digits of the year. All colons and spaces are required.

7. Latitude and longitude information shall be displayed in separate fields.

8. The latitude label may be abbreviated to Lat. Latitude shall be presented to and supplied by the operator in the DD°MM'SS.T" (09°06'30.3"N) format. A two-digit degree and the hemisphere (N or S) are required. Minutes, seconds, and tenths of seconds are optional. If provided, minutes and seconds each must contain two digits. All symbols are required if

preceded by a number and the hemisphere (N or S) shall be capitalized. A hyphen may be substituted for the degree and minute symbols DD-MM-SS.T (09-06-30.3). The system should know in which hemisphere it is located and use this as the default value.

9. The longitude may be abbreviated to Long. Longitude shall be presented to, and supplied by, the operator in the DDD°MM'SS.T" (090°06'30.3"E) format. DDD is the degrees of longitude, MM is the minutes of longitude and is optional; SS is the seconds of longitude. A three-digit degree and the hemisphere (E for East or W for West) are required. Minutes, seconds, and tenths of seconds are optional. If provided, minutes and seconds must each contain two digits. Seconds of longitude are only presented if minutes are presented. All symbols are required if preceded by a number. The hemisphere (E or W) shall be capitalized. A hyphen may be substituted for the degree and minute symbols DDD-MM-SS.T (090-06-30.3). The system should know in which hemisphere it is located and use this as the default value.

10. A latitude/longitude group shall be presented to and supplied by the operator in the DD°MM'SS.T" / DDD°MM'SS.T" (09°06'30.3"N /090°06'30.3"E) format. All symbols are required if preceded by a numeric value. Hyphens may replace degree and minute symbols and the second symbol may be omitted. Latitude shall always precede longitude by either being above or to the left of the longitude value. Two possible latitude/longitude groupings are shown below. The degrees and hemisphere is required in both latitude and longitude. Minutes, seconds, and tenths are optional in both but shall follow the guidance described in this document.

    - Lat: 09°06'30.3"N

      Long: 090°06'30.3"E

    - Lat/Long: 09°06'30.3"N / 090°06'30.3"E

Source

CSFAB, TBM, DISA, UCA.

Discussion

G1. The appropriate format for the date information depends on the use to which the information will be put. The YYMMDD format does not disambiguate the month and day fields across international conventions and thus is not recommended. The DDMMYY format provides an advantage because it is consistent with the order of the elements in the preferred Date Time Group format. If the date is to be conveyed to other entities that are expecting the YYMMDD format then the international conventions affect the display of choice. If the operators must report or otherwise convey the two-digit number for the month, then support for the conversion shall be provided.

G2. DISA and TBM call for a similar display, but without the colon separators. The display is easier to read if colons are used to separate the time groups.

G4. Although the time is presented in the lower right hand corner of the screen in Microsoft Windows; the upper right hand corner is recommended to maintain consistency with other combat systems.

G6. DISA and TBM call for a similar display, without the colon separators or space between the day and the time.

G8. CSFAB states that the abbreviation may be LAT or Lat. Lat is the preferred abbreviation because the abbreviation is not an acronym.

G9. DISA and TBM call for the Hemisphere to be placed in front of the longitude numbers if thousands of minutes are displayed. CSFAB states that the abbreviation may be LONG or Long. Long is the preferred abbreviation because the abbreviation is not an acronym.

G10. The option to display Latitude and Longitude as “Lat: 09°06'30.3"N Long: 090°06'30.3"E” was not considered because it is more difficult to extract the salient information from that format.

18.3 Graphical schedules

1. A graphical schedule displays timelines or scheduled events. A scheduled event shall be represented by an event object that shall be a line, bar or other object whose length is proportional to the amount of time necessary for a particular task or task element.

2. A graphical schedule shall be presented in a horizontal format and shall present the schedule tasks or resources on the left side or y-axis of a graph. Time shall be presented along the x-axis. Each schedule event shall be displayed by an object to the right of its associated task.

3. If appropriate to the application, different types of events or events undertaken shall be differentiated by colour coding, shading, or short alphanumeric designations on or above the event icons.

4. If a coding scheme is applied to a schedule, users shall have access to a key that describes the graphical coding technique utilized. It is recommended that no more than nine differently coded event icons be presented on a schedule at one time.

5. If frequent schedule changes are anticipated, users shall have the capability to reschedule an event object by directly manipulating the event object by means of the pointing device (e.g., dragging and dropping).

6. An alternative means (other than dragging and dropping) to locate an event object on a schedule shall also be supplied. For example, one alternative is to support direct text entry of an event object start and stop times.

7. Users shall have the capability to select a schedule start and stop time to be displayed in a graphical schedule window. This duration time can be a superset of what can be displayed in the window at one time. Users shall also have the capability to display all or a subset of the pre-selected duration time. For example, a schedule duration may display a week; however, users may choose to display one or more days out of the pre-selected week.

8. If graphical schedules are overly cluttered or require a high level of precision, grid lines shall be used to correspond with individual tasks or resources and times.

9. If required by the application, users shall have the capability to display or suppress a gridline that indicates the present date and time on the schedule.

10. Users shall have the capability to select an individual event object and obtain additional information about that event.

11. If more than one event icon is used per task or resource, then a label shall be supplied for each event icon that is a part of the task or resource being scheduled. For example, a schedule may display planned and actual times or earliest, latest, and actual times.

12. If appropriate for an application, symbols shall be combined with event objects to display different scheduling attributes.

Source

TBM.

18.4 List-to-list transfer

A list-to-list transfer is used to copy (or move) items from a source list (master list) to a destination list. Figure 29 depicts a typical convention used for performing this type of action.

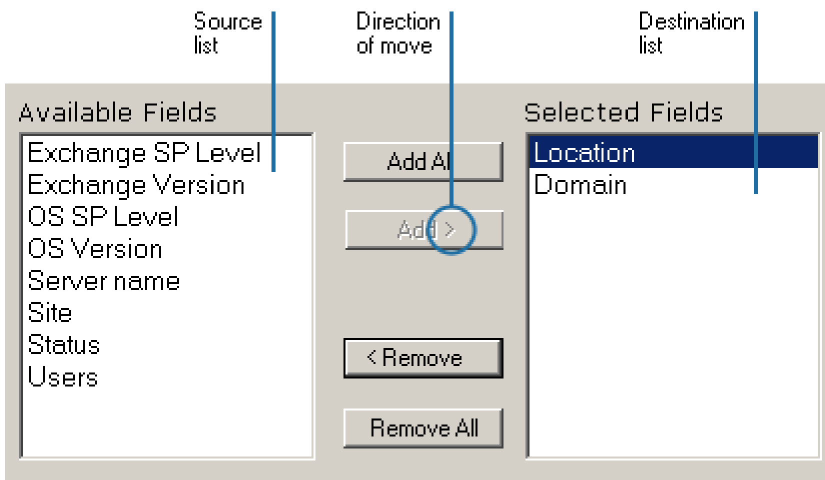


Figure 29: Example of a list-to-list transfer.

1. A task window used to copy items from a source list (master list) to a destination list shall provide one Add and one Remove button. If many items are in a list an Add All and/or a Remove All button may also be included. The labels Add and Remove may be altered to more closely fit the task for which the list-to-list transfer is being used.

2. List to list transfers shall follow the Microsoft Windows conventions.

3. Vertically arranged push buttons shall be located between the two lists and shall be used to invoke the functions Add All, Add, Remove, and Remove All. Add All shall be on the top, then Add, then Remove, and Remove All on the bottom. Selecting one or multiple items from the original list and selecting Add shall move these items to the destination list. Selecting Add All shall move all items from the original list to the destination list.

Selecting one or multiple items from the destination list and selecting Remove shall move these items to the original list. Selecting Remove All shall move all items from the destination list to the original list.

4. In some tasks it may be preferable to copy instead of move items from the original list to the destination list. Items shall then be marked with an asterisk to show they have already been copied. Multiple copies of the same items shall not be allowed in the original or destination lists. The push buttons from top to bottom shall read: Copy All, Copy, Remove, Remove All.

5. The Add/Copy push button is only enabled when an item is selected in the original list. The Remove push button is only enabled when an item is selected in the destination list. The Add/Copy All and Remove All push buttons are always enabled unless there are no items in the original or destination lists respectively. If an item is selected in the original list, the Add/Copy button shall be the default. If an item is selected in the destination list, the Remove button shall be the default.

6. Double clicking an object in either list shall move or copy it to the other list.

7. The Remove button shall be enabled and the Add button shall be disabled if an item in the destination list is the only selected item.

8. The Add button shall be enabled and the Remove button shall be disabled if an item in the source list is the only selected item.

9. The user shall not be allowed to remove an item from the source list.

10. Moving an item from the source list to the destination list in a list-to-list transfer box shall not permanently remove the item from the source list.

11. List-to-list transfer windows shall support drag transfer actions (drag and drop) from one list to another.

12. The Add and Remove buttons shall include a graphic showing the direction of transfer.

Source

CSFAB, TBM, UCA.

18.5 Message handling

18.5.1 Message handling windows

1. Except for broadcast communication systems, the transmitter of each message in inter-user communications shall be identified automatically.

2. Message preparation windows shall follow the same design as data entry windows.

3. Users shall be given basic message header fields that are supported in specifying the message address.

4. Option menus may available for selecting from limited sets of frequently used terms.

5. When replying to a message, the appropriate addressee(s) shall be provided automatically.

6. Users shall have the capability to build and maintain lists of common addresses and select from these lists when preparing messages, if that functionality is required.

7. If functionality is required by an application, addresses are checked prior to transmission; users can correct errors before sending.

8. Preformatted standard forms are available and format control during entry is automatic.

9. Users shall be able to specify data, incorporate data files, and save during preparation/completion.

10. Each individual data group or message shall contain a descriptive title, phrase, word or similar device to designate the content of the group or message.

11. The notification of the message (or alert) shall indicate, at minimum, an indication of the number of alerts in each category (e.g., flash messages, system messages, or tactical messages).

Source

TBM, UCA.

18.5.2 Message transmission

1. Message transmission procedures shall be designed to minimize the user actions required.

2. Users shall have the capability to initiate message transmission directly (e.g., select a transmit push button) or to set a transmission time.

3. If a message cannot be sent immediately, it shall be queued automatically.

4. If functionality is required by an application, users may assign message priorities and cancel or terminate a transmission.

5. Status feedback shall be available that confirms messages sent and indicates failures.

6. Users shall be able to specify what feedback they want to receive; an automatic log of this information shall be maintained.

7. If functionality is required by an application, undelivered messages are saved in the event that there is transmission failure.

Source

TBM, MH761.

18.5.3 Message receipt

1. Users shall be informed when high-priority messages are received.

2. Message notification shall not interrupt operator tasks, but shall provide an indication of urgency.

3. The presence of non-system generated messages that do not require immediate operator intervention shall be indicated.

4. The messages shall be presented in order of priority followed by the most recently received messages.

5. The highest priority messages shall be indicated with a colour coded with a red (or magenta) symbol in the message notification area.

6. The title bar of a message window shall be colour coded to match the priority code of the message (Red for Flash messages).

7. If functionality is required by an application, incoming messages shall be automatically queued by time and priority; logs shall be maintained.

8. Users can review summary information, display messages, save/file, and discard.

9. A message shall be displayed in a text window and users can scroll, save, and print the message.

10. During login, a system shall provide users with a list of new messages received.

11. Data transmission functions shall be integrated with other information handling functions within a system. A user shall be able to transmit data using the same computer system and procedures used for general entry, display, and other processing of data.

12. Procedures for preparing, sending and receiving data and messages shall be consistent from one transaction to another, and consistent with procedures for other information handling tasks.

13. The data transmission procedures shall minimize memory load on the users by providing computer aids for automatic insertion of standard information, such as headers and distribution lists.

14. Users shall be able to interrupt message preparation, review, or disposition and then resume any of those tasks from the point of interruption.

15. Where message formats conform to a defined standard or are predictable in other ways, stored forms shall be provided to aid users in message preparation.

16. Users shall be able to incorporate an existing data file in a message, or to combine several files into a single message for transmission and to combine stored data with new data when preparing messages for transmission. It shall not be necessary to re-enter any data already entered for other purposes.

17. When users must specify the address for messages, prompting shall be provided to guide the user in the process.

18. Users shall be provided with an on-line directory showing all acceptable forms of message addressing for each destination in the system, and for links to external systems.

19. Computer aids shall be provided so that a user can search an address directory by specifying a complete or partial name. It shall also be possible to extract selected addresses from a directory for direct insertion into a header in order to specify the destination(s) for a message.

Source

TBM, MH761, MS1472F, UCA.

18.6 Spell checking

Spell checking can highlight erroneous entries to the user as well as provide suggestions for corrections. For instance, Microsoft Word provides the following dialog box (Figure 30) to assist the user with checking the spelling of a text document.

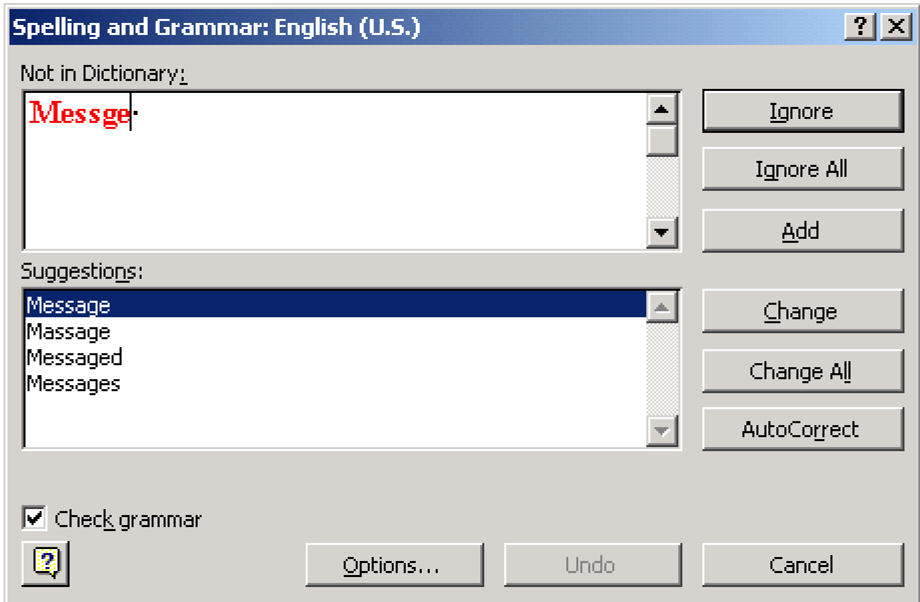


Figure 30: Example of a spell checker window.

1. Spell checking displays and operation shall be consistent with Microsoft Windows styles.

2. A task window used to perform spell checking on a text document or message segment shall display the unknown word to the user in an uneditable text field.

3. An unknown word identified by the spell checker shall appear in an editable text field so that the user can edit the unknown word.

4. The system shall provide a default dictionary of common words, abbreviations, etc., used in the application. This dictionary shall be tailored for the application task.

5. The user shall be able to view suggestions from the dictionary on how to correct an unknown word.

6. The user shall be able to select a word from the list of suggestions and have the option of editing the word before replacing the unknown word.

7. The user shall have the option of replacing all instances of a given unknown word with the specified corrected word or replacing each instance individually. If a user chooses to globally replace all instances of a given unknown word, the spell checker shall automatically replace the word without acknowledgment from the user and shall not interrupt the spell checking process.

8. The user shall be allowed to skip an unknown word without changing it.

9. The user shall be given the option to skip all instances of an unknown word for the remainder of the document or to skip the current instance only.

10. The user shall be able to specify the direction of the spell check relative to the current position.

11. The user shall be able to cancel the spell check operation at any time.

12. Spelling and other common errors shall not produce valid system commands or initiate transactions different from those intended. When possible, the system shall recognize common misspellings of commands and execute the commands as if spelling had been correct.

13. Computer-corrected commands, values, and spellings shall be displayed and highlighted for user confirmation.

Source

TBM, MS1472F, UCA.

18.7 Printing

Print dialog boxes allow the user to specify print settings such as the capability to print a single page, or a sequence of pages, by specifying the page numbers. Figure 31 illustrates a Microsoft Word dialog box with the ability to adjust printer settings. Printer settings depicted here include the choice of output printer, page range, number of copies, and zoom size.

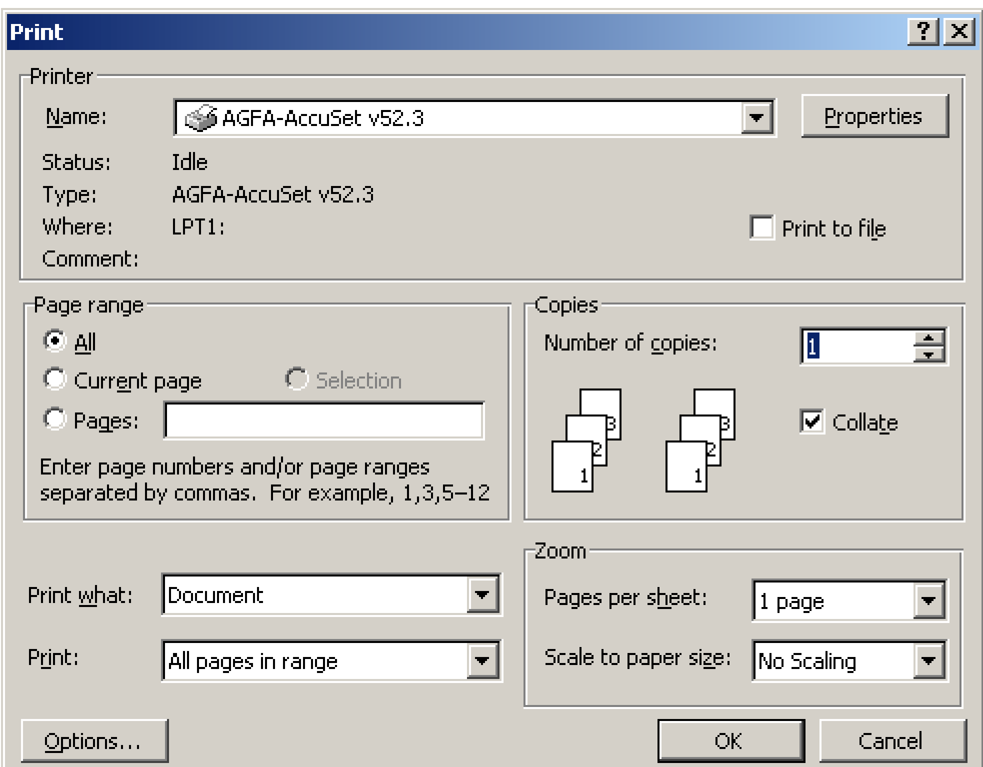


Figure 31: Example of a print dialog.

1. The design details of the printer controls shall be consistent with MSWUE (see MSWUE, Chapter 9) guidelines.

2. Users shall be able to save, access, retrieve, rename, and print text documents.

3. Users shall be provided the capability to specify the portions of the document to be printed and the printer on which the document is printed.

4. When printing text, users shall be allowed to select among available output formats (e.g., line spacing, character size, margin size, heading, and footing) and to specify the pages of a document to be printed.

5. The user shall have the capability to obtain a paper copy of the contents of the alphanumeric or digital graphic display in those systems where the following conditions apply:

   - Mass storage is restricted.
   - Mass stored data can be lost by power interruption.
   - Record keeping is required.

6. The user shall be able to print a display by simple request, without having to take a series of other actions first. An example of an unacceptable series of action is: calling for the display to be filed, specifying a filename then calling for a print of that named file.

7. The user shall have the capability to print a single page, or sequence of pages, by specifying the page numbers.

8. The system shall acknowledge the print command and provide the status of the printer and queue.

9. The printer control shall permit the operator to elect to print screen capture of the tactical display, if required.

Source

TBM, MS1472F, MSWUE, UCA.

18.8 Imagery manipulation

18.8.1 Imagery appearance

1. An imagery window shall contain an imagery display and a set of tools for manipulating the image.

2. An imagery window shall include identifying information about the image displayed and this information shall be displayed in a standard location.

3. When an entire image does not fit on a screen, the users shall be provided with the capability to scroll, pan, and zoom.

4. An imagery window shall contain resize handles and resizing the window shall have an effect on the image contained in the window.

5. An imagery system shall permit users to access and retrieve an image for display from a directory of images.

6. An imagery system shall permit users to specify the name of the image or search the directory of images for images matching user-defined criteria, including wild card searches.

7. An imagery system shall permit users to print in full-resolution or low-resolution an image displayed in an imagery window.

Source

TBM.

18.8.2 Imagery viewing functions

1. An imagery window shall permit users to roam or pan an image in both the horizontal and vertical direction.

2. When panning or roaming an image, automatic, jump, manual, and patterned roam control shall be available and an imagery system shall permit users to specify the rate, direction, and area of interest as appropriate.

3. As users pan or roam an image, the imagery system shall permit users to tag specific areas of interest for later recall while the image remains in the display area.

4. An imagery system shall permit users to zoom an image in predefined increments or in user-defined increments.

5. An imagery system shall support image chipping. Image chipping allows users to select and designate regions of an image for storage.

6. An imagery system shall permit users to create and manipulate annotations to display with an image. Annotations shall include text, lines, icons, geometric shapes, colours, and patterns.

7. Image annotations shall be edited, deleted, repositioned, resized, saved, and retrieved without altering the underlying imagery data.

8. When an image is manipulated (e.g., resized, rescaled, etc.), the scale and orientation of image annotations shall be adjusted to accommodate the changes. However, textual annotations shall remain constant.

Source

TBM.

18.8.3 Advanced imagery viewing functions

1. An imagery system shall provide image enhancement filtering capabilities to control the dynamic range of imagery data by modification of intensity and contrast.

2. An imagery system shall permit users to select and examine (e.g., zoom, roam) a region of interest within an image leaving the remainder of the image unaffected.

3. Imagery windows shall provide measurement functions for computing lengths, areas, and volumes from dimensions or angles. Imagery windows shall also provide the capability to perform isotropic pixel correction (i.e., convert rectangular pixels to square pixels for display purposes).

4. Imagery windows shall permit users to create a mirror view of the image so the image can be adjusted if the negative was inverted when scanned.

5. Imagery windows shall provide a default image rotation where vertical objects are oriented toward the top of a window and an automatic north rotation where north is oriented at the top of the window. Imagery windows shall also permit users to rotate images in user-defined increments.

6. When an image is manipulated in an image window, the scale and orientation of annotations shall be adjusted according to the type and nature of the symbol.

7. An imagery system shall permit users to plot user-selected geographic data on the image, including frame-by-frame plotting to animate the data in either a forward or reverse time direction.

8. An imagery system shall permit users to register (i.e., transform an image so that it aligns with either another image or a map projection) geo-referenced images acquired from the same or different sensors and display them together.

9. An imagery system shall permit users to perform concurrent geometric manipulations on separate geo-referenced windows that have overlapping geographic coverage.

10. Users shall be able to "slave" together multiple geo-referenced windows and manipulate (e.g., roam, zoom, rotate) all the slaved windows concurrently and relatively (i.e., with the window centres maintained at a common centre latitude/longitude position), despite differences in the amount and distance coverage between windows.

Source

TBM.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of all functions and formats in the OMI.

Operator performance:

- Objective assessment of use and usefulness of all special functions and formats.

Operator acceptance:

- Subjective assessment of the adequacy of the operator's perceptions of usability and utility of all special functions and formats in the OMI and ESS.

19 Graph display

Graphs can be used to present assessment of trend information, spatially structured data, time critical information or relatively imprecise information. There are a number of types of graphs; an example of a line graph and a bar graph is presented in Figure 32Figure 33.

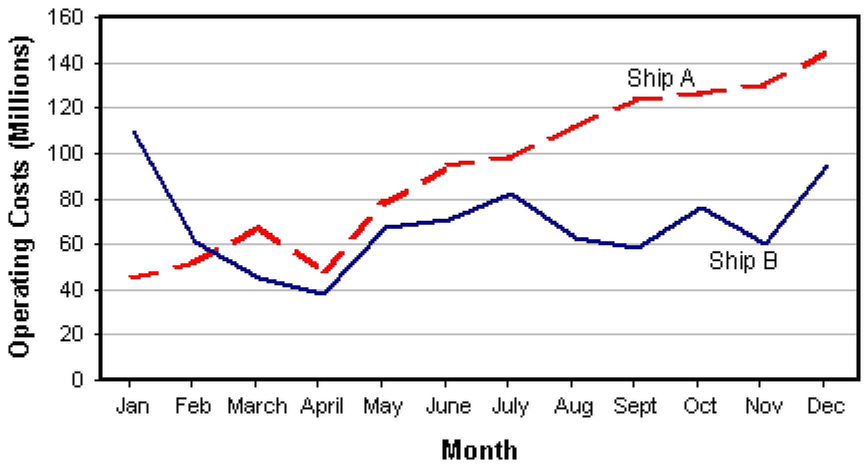


Figure 32: Example of a line graph.

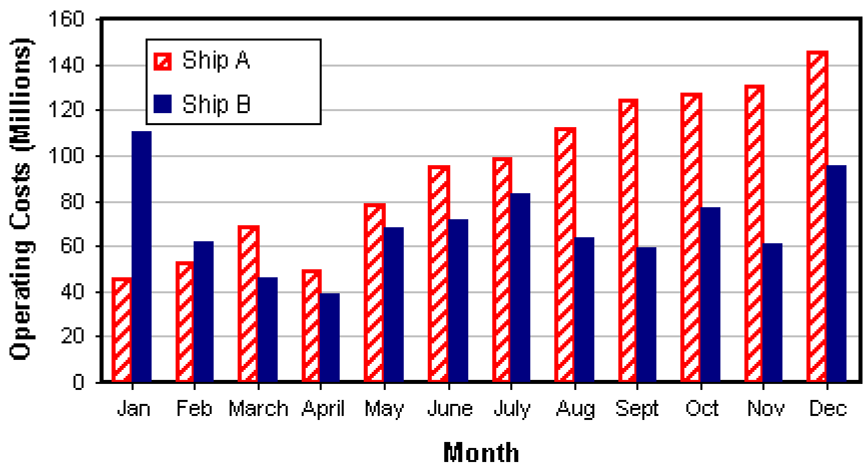


Figure 33: Example of a bar graph.

19.1 Graph display characteristics

1. Displays of graphs shall be used to present assessment of trend information, spatially structured data, time critical information or relatively imprecise information.

2. When users must compare graphic data across a series of charts, the same scale shall be used for each chart.

3. The window shall include a title and shall be sized so that the entire graph is visible.

4. Users shall not have to scroll or resize a graph display window to view its contents.

5. Charts and axes shall be clearly labelled, and important information shall be highlighted.

6. When a user must compare graphed data to some significant level or critical value, a reference index or baseline shall be included in the display.

7. When precise reading of a graph may be required, the capability shall be provided to supplement the graphic representation with the actual numeric values.

8. Where graphs are presented, only a single scale shall be shown in each axis, rather than including different scales for different curves in the graph. If interpolation must be made or where accuracy of reading graphic data is required, the user shall be provided with computer aids.

9. Linear scales shall be used in preference to logarithmic or other non-linear scales.

10. Gradations shall be at standard intervals; intervening gradations shall be consistent with the labelled scale.

11. Labels shall be used instead of legends or keys to identify the data.

12. The labels shall be oriented horizontally and located next to the data being referenced.

13. Gridlines shall be unobtrusive and shall not obscure the data presented in the graph.

14. Users shall be provided the capability to display or suppress gridlines as desired.

15. The same coding scheme shall be used consistently throughout an application.

16. Users shall be able to re-draw multiple graphs using the same scale to facilitate comparison.

17. For precise values, users shall be able to display the actual values on the graph and to zoom.

Source

TBM, DISA, MH761, MS1472F.

19.2 Line graphs

1. Line graphs or curves shall be used for displaying relations between two continuous variables. This includes trend information, spatially structured information, time critical information, or relatively imprecise information.

2. The axes of the graph shall be clearly labelled and include the unit of measurement as appropriate.

3. The labels shall be in mixed-case letters and oriented left to right for normal reading.

4. The horizontal (x-axis) shall be used to plot time or the postulated cause and the vertical (y-axis) shall be used to plot a caused effect when these variables are appropriate.

5. Minimum/maximum values shall be shown on each axis, with up to nine intermediate markings.

6. The starting point of an axis shall be zero, with the gradations indicated in whole numbers unless zero is an inappropriate starting point and whole numbers are inappropriate.

7. When graphed data represents only positive numbers, the graph shall be displayed with the origin at the lower left. When data includes negative values and the axis extend in both directions from a zero point, the origin shall be displayed in the centre of the graph.

8. Each line or curve on a graph shall be labelled and coded and critical or abnormal data shall be coded.

9. Multiple trend lines shall be presented on a single graph.

10. Where users must evaluate the difference between two sets of data, that difference shall be plotted directly as a curve in its own right, rather than requiring users to compare visually the curves that represent the original data sets.

Source

TBM, MH761, MS1472F.

19.3 Surface charts

1. When curves represent all of the portions of a whole, surface charts shall be used to display aggregated amounts.

2. The area defined below the curves or lines in a surface chart shall be textured, shaded, or coloured.

3. Data categories in a surface chart shall be ordered such that the least variable curves are displayed at the bottom and the most variable at the top.

4. If space is available, labels shall be placed within the textured or shaded bands, the labels shall be easily readable within the bands.

Source

TBM, DISA, MH761.

19.4 Bar charts and histograms

1. Bar charts shall be used when comparing a single measure (e.g., number of eligible recruits, thousands of dollars, etc.) across a set of several entitles (e.g., geographic regions, level of education, religion, etc.) or for a variable sampled at discrete intervals. Histograms (bar graphs without spaces between bars) shall be used when there are a great many entities or intervals to be plotted.

2. In a related series of bar graphs, a consistent orientation of the bars (vertical or horizontal) shall be adopted.

3. When data must be compared, bars shall be adjacent to one another. Adjacent bars shall be spaced such that a direct visual comparison can be made without eye movements

4. A reference index shall be provided when displayed values must be compared with some critical value.

5. Use of iconic representations of quantitative information (e.g., using a silhouette of a person to represent 1000 people) shall be avoided.

6. When bars are presented in pairs, they shall be labelled as a unit, with a legend provided that distinguishes between the bars.

Source

TBM, DISA, MH761, MS1472F.

19.5 Flow charts

1. Flow charts shall be used for a schematic representation of sequences or processes.

2. The steps in a flow chart shall be presented in a logical order (e.g., a process by sequence of activity or by decreasing importance to mission success).

3. If there is no inherent logic, the steps shall be ordered to minimize the size of the flow chart.

4. The path indicated in the flow chart shall be left-to-right, top-to-bottom, or clockwise.

5. Each decision point in the flow chart shall contain a single, simple decision.

6. The flow chart elements and lines shall be consistently coded to assist in understanding.

7. The flow chart shall provide direction indicators to indicate the sequence to be followed.

8. A legend shall describe each element and code; critical information, and/or steps shall be highlighted.

Source

TBM, DISA, MH761.

19.6 Manipulation and creation of graphical data

19.6.1 Manipulation of graphical data

1. When an application allows users to manipulate graphical data, the application shall allow the following:
   - Users shall be able to select and edit graphical object attributes (e.g., colour, line thickness, and font size).
   - Users shall be able to enlarge or reduce graphical object sizes.
   - Users shall be able to fill enclosed graphical areas with colour and patterns.
   - Users shall be able to remove and restore selected elements of the display.
2. If appropriate, applications shall automatically align graphical objects to an invisible rule or grid structure. Alignment shall be able to be turned on or off at the discretion of the user.
3. For most graphics data entry, pointing shall be a dual action, with the first action positioning the cursor at a desired position and the second action confirming that position to the computer. An exception may be a design that allows "free-hand" drawing of continuous lines.
4. Drawn objects shall be able to be easily repositioned, duplicated, and deleted.
5. When appropriate, users shall be able to group separate objects into a single, grouped object (so that separate objects may, for example, be moved as a unit, or so that a complex object can be incrementally drawn).
6. When editing graphic data, users shall be provided with the capability to change the size (scale) of any selected element on the display, rather than delete and recreate the element in a different size.
7. A copy of the original graphics is retained until users confirm that the objects are to be changed. The objects are not modified automatically as users change them.
8. Objects are displayed as they will be printed (or a print preview option is available to see this format).

Source

TBM, MH761, MS1472F.

19.6.2 Creating graphical data

1. The system shall provide a set of appropriate drawing tools. Whenever drawing tools are provided they shall use the icons and options described in MSWUE.

2. Drawing tools shall provide the operator with easy means to draw required tactical objects. New drawing tools and icons shall be provided if required.

3. Objects shall emerge as they are drawn.

4. Applications shall automatically complete figures (e.g., closure of a polygon) upon demand and shall draw lines between user-specified points.

5. Users shall be able to draw objects such as lines, rectangles, ovals, and arcs.

6. When line drawing is required, users shall be provided with aids for drawing straight line segments. When line segments must join or intersect, computer aids shall be provided to aid in such connection.

7. When a user must draw figures, computer aids shall be provided for that purpose (e.g., templates, tracing techniques, stored forms).

8. When appropriate, users shall be able to constrain line drawing to exactly vertical or horizontal. For precise drawing, users shall be able to specify their geometric relations to other lines (e.g., parallel or perpendicular to another line).

Source

TBM, MH761, MS1472F, MSWUE, UCA.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of graphical information and graphics tools in the OMI.

Operator performance:

- Objective assessment of use and usefulness of graphical information and graphics tools through usability testing.

Operator acceptance:

- Subjective assessment of the adequacy of the operator’s perceptions of usability and utility of graphical information and graphics tools in the OMI and ESS.

20 Tactical graphics

20.1 Tactical graphics characteristics

1. Colour shall only be used when it will increase operator performance or situational awareness.

2. Colour shall be used as a redundant cue to segregate tracks in the tactical display.

3. The maximum number of colours for symbols and their associated tracks shall be five.

4. When the operator's tasks do not require the search for objects and if colour will not provide any added information to the operator, then grey will probably be the best colour choice for that object. Objects that are colour coded shall also be redundantly coded by some other means such as fill pattern or shape.

5. The number of coding shapes shall be limited to five. Simple geometric shapes are recommended. Designers shall follow the standard notation of pointed shapes meaning hostile or danger and round shapes meaning friendly or OK; the over-riding source for design of coded shapes shall be the NTDS, or other conventions as specified.

6. Shapes (and colours) for track symbols, and other symbology, shall follow the NTDS conventions with the caveat that the Canadian Forces may require STANAG 4420 or Military Standard 2525 (Common Warfighting Symbology). Without further research only those elements of STANAG 4420 or Military Standard 2525 that correspond to the current NTDS symbols should be used.

7. A maximum of two different sizes shall be used to code information.

8. Where size difference between symbols is employed, the major dimension of the larger shall be not less than 150% of the major dimension of the smaller.

9. Position is generally reserved to display geographic information. Position shall not be used to determine quantitative information but can be used to display qualitative information. Qualitative judgments are generally a relative judgment task (e.g., one symbol is higher, closer, etc. than another symbol).

10. When special symbols are used to signal critical conditions, they shall be used for only that purpose.

11. Limit the number of different orientations to twelve (like a clock) and preferably eight. This code shall generally be reserved for displaying directional information but maybe combined with shape information to further designate a symbol (e.g., a triangle means hostile; up is a hostile air, up and down is a hostile surface, and down is a hostile subsurface). Symbols of the same shape shall have some common bond regardless of orientation (e.g., all triangles are hostile).

12. Alphanumerics shall be used with multiple (greater than eight) states or levels that must be absolutely distinguished. For memory purposes the number of "chunks" in a code shall be limited to four. Case-sensitive coding shall be avoided except for passwords.

13. Only two levels of intensity (brightness) shall be used. Brightness shall only be used as a code if the objects coded are adjacent. Each level shall be separated from the nearest other level by not less than a 2:1 ratio.

14. An object coded with the lesser of two intensities shall be less important for that particular task and shall not create a problem if ignored or overlooked by the operator.

15. Reverse video shall not be used for coding.

16. The display shall provide a visual distinction between system-generated and manual upgrades of a track.

Source

CSFAB, MS1472F, UCA.

Discussion

G7. CSFAB and MS1472F limit the number of sizes to three.

G13. Absolute brightness is difficult to interpret. Using brightness as a code shall be avoided.

Evaluation methods and measures

Design verification:

- Verification of ease of use and design consistency of tactical graphics in the OMI.

Operator performance:

- Objective assessment of use and usefulness of tactical graphics through usability testing.
- Objective assessment of speed and accuracy of detection and recognition of critical objects and tactical information on a tactical display.

Operator acceptance:

- Subjective assessment of the adequacy of the operator's perceptions of usability and utility of tactical graphics in the OMI and ESS.

Operator situation awareness:

- Subjective assessment of the adequacy of the operator's situation awareness of the tactical picture.

21 Maps and situation display

21.1 Radar

21.1.1 Single radar

1. Returns from a single radar shall normally be in grey scale with stronger returns depicted by brighter grays. Any number of grey scale levels may be used but more than 16 to 20 levels will have diminishing returns. Any sections not covered by radar shall be outlined in black.

Source

CSFAB.

21.1.2 Multiple Radars

1. Separate radars may be designated by a separate colour return or by a coloured border around its area of operation. If radars are operating in the same sections, they must be given a hierarchy by the operator that the system shall use to determine layering of the returns.

2. A maximum of three different colour returns may be used to depict separate radar returns. For coloured returns, use the same hue and saturation while changing the colour's brightness to display the radar return strength. Stronger returns shall be depicted by brighter colours. Any sections not covered by radar shall be outlined in black.

3. A maximum of six different coloured borders may be used. The coloured border is placed around the section where the radar is operating. The border may also be made to fade at the same rate as the radar return. If multiple radars overlap, the outlines of higher altitude radars shall be to the inside of other radars. The radar return for all radars with coloured borders shall be displayed as grey scale levels with stronger returns being brighter.

4. The operator shall be able to independently control both the fade and sweep rates for each radar.

Source

CSFAB.

21.2 Tactical displays

21.2.1 Tactical display characteristics

1. The tactical picture display for the CCS shall occupy no less than 60% of the complete display area on the screen. If multiple monitors are implemented for a single console, then the tactical picture display shall occupy no less than 60% of the complete display area on the primary screen.

2. A tactical display window may contain both a tactical display and a set of controls for manipulating the display.

3. A tactical display area shall include identifying information about the tactical display (e.g., map name, area, scale) in the title bar.

4. Status information (e.g., coordinates, "drawing map", "updating map") shall be provided.

5. The tactical display window shall be supplemented by windows or information areas that provide amplifying information about selected objects and symbols.

6. The tactical display shall be initially presented in a default range that is appropriate to the operator position to provide the operator an overall tactical picture.

7. Users shall select and deselect symbols on the tactical display using standard selection methods.

8. Labels shall be able to be applied to any object on the tactical display. All labels are global so that once an object is given a label; other operators must use this label. As a default the label shall only be displayed in the amplification window, but each user shall have the ability to also display any label on the map. In either case, the label shall always be displayed in the amplification window. Only the originator and authorized operators may alter global labels.

9. The tactical display shall be a fixed window and take on all characteristics of fixed windows.

10. The tactical display shall be located on the right-hand side of the monitor.

11. The tactical display shall include a means by which users can obtain help in identifying unknown symbols or other object information.

Source

CSFAB, TBM, DISA, UCA.

Discussion

G1. The Halifax-Class CCS tactical picture display is approximately 60% of the display area on a single screen.

G10. The tactical display should be located near an anchor point on the screen. The right-hand side was selected to retain consistency with the Halifax-Class CCS OMI.

21.2.2 Tactical tools

1. Controls that affect the tactical display map, such as range selection and overlays, shall be located in an area just below the tactical display.

2. The operator shall be able to enter geographic points (such as lat/long) to identify locations for graphic elements. Examples include specifying the location of a specific object or setting the parameters for a geographic area.

3. Tactical displays shall provide a distance/azimuth function that calculates the distance (range) and azimuth (bearing) between any two selectable points or symbols. Distance shall be presented in user-selectable units (in feet, meters, miles, nautical miles, or kilometres). Azimuth shall be displayed in degrees from true North.

4. The software shall provide a means to determine the range and bearing between any two points on the tactical display. The first point shall be selected by the operator and the second point will be the current location of the pointer. A line shall be drawn between the first point and the pointer location. As the pointer moves, the range and bearing information shall be updated. The bearing shall be given from the first point to the second point.

5. Tactical displays shall provide an automated means for determining the bearing and range between points. If users need to judge precise distances, computer aids may be provided.

6. Bearing and range lines shall display the bearing and range (in that order) near the bearing and range line approximately 1/3 of the distance between the two points and closest to the second point chosen.

7. The display of bearing and range lines shall be operator-selectable as in an overlay.

8. The tactical display shall provide a position determination function that calculates the position of an identified point. The point is provided by latitude and longitude, distance (in feet, meters, miles, nautical miles, or kilometres), and an azimuth. Coordinates shall be provided in a user-selectable coordinate system (e.g., Universal Transverse Mercator, latitude/longitude, or Military Grid Reference System).

9. The software shall provide a means to determine the latitude and longitude location of the pointer at any location on a tactical display. The software shall also provide the bearing and range of the pointer location from Ownship.

10. The software shall provide a means to compute a running distance along a series of lines. This would be used to determine non-straight line distance.

11. The software shall provide a means to determine an area by defining a circle, rectangle, or polygon region.

12. An operator shall be able to select a contact, input a time, duration and bearing (default to current bearing) and the software will provide a predicted location for that contact assuming its bearing does not change.

13. By selecting two tracks (or contacts) or one track (or contact) and a fixed point, the operator shall be able to see dead reckoned lines and the location of the closest point of approach (CPA).

14. The tactical display shall provide a direction function that allows users to designate direction by pointer placement using the pointing device, entry of bearing and elevation angles, or specification of points of interest.

15. When tactical display location data is frequently used, a constantly visible display of coordinates associated with the pointer shall be displayed in appropriate coordinate units. The continuous display of location shall be augmented with the capability to fix (point on the tactical display) a location to facilitate moving overlay displays. If appropriate to the application, the capability to fix a location on the display and label it for storage, retrieval and cantering of the display may be provided.

Source

CSFAB, TBM, DISA, UCA.

21.2.3 Drawing tools

1. The system shall provide a set of appropriate drawing tools. The operators shall only be provided with drawing tools that have operational relevance. Whenever operationally relevant drawing tools are provided they shall use the symbols and options described in MSWUE.

2. New drawing tools and symbols shall be provided if required. Such tools shall provide the operator with easy means to draw the required tactical objects.

3. Drawing tools shall include means for the objects to re-size or re-locate according to defined specification. For example, the drawing tool that supports drawing of an expanding area of interest must permit the operator to specify the rate of expansion.

4. Detailed specification of the actions of drawn objects shall be operable from the drawing tool and shall not require additional menus to be opened.

5. When line or figures must be drawn to represent numeric coordinates, computer aids shall include templates for entering the coordinates, and if necessary, selecting the appropriate units for those coordinates.

6. Where graphic data must be plotted in predefined standard formats (e.g., target areas on maps), templates or skeletal displays shall be provided for those formats to aid data entry.

7. Map points shall include a point designation feature (e.g., cross hairs or a V-shaped symbol).

8. The OMI shall support direct manipulation of displayed objects on the situation display. Examples include selecting drawn objects and moving or dropping them.

Source

CSFAB, DISA, MS1472F, MSWUE, UCA.

21.2.4 Selecting contacts or objects

21.2.4.1 Primary hooking

1. Selection aids shall be available to assist the user in the visual location and selection of a symbol or graphic object in a display with many other closely spaced or overlapping objects. These aids shall include an interactive track group list, sequential symbol hooking without pointer movement, a user-defined contact list, location by contact name and/or number, and sequential switching.

2. Users shall be able to hook a track by placing the pointer over the symbol and performing a select. A contact that is hooked shall be placed in the visual "foreground" such that no other contacts obscure it or partially cover it.

3. In contact-rich environments it is not always possible to determine which of the objects is hooked if the sole visual indicator on the tactical display is a graphic (such as the rounded shape currently used) surrounding the contact. The capability to step through overlapping tracks is necessary, but not sufficient. An auxiliary visual cue (e.g., making the hooked contact appear brighter for a period after it is hooked) shall be implemented.

4. Contacts shall be automatically pre-selected when they are closest to the pointer. Pre-selection provides operator specified contact information in the pre-hook window and indicates to the operator which object will be hooked if the operator performs a select. A white, dotted circle shall be placed around contacts when they are pre-selected unless the contact is already selected.

5. Users shall be able to select a single object on a map within a densely packed group of objects. When a graphical item is selected, it shall be highlighted. If appropriate to the application, users may reposition selected elements on the display.

6. Symbols other than contacts, such as special points or Identify Friend/Foe (IFF) symbols, are highlighted in the same manner as contacts.

7. Selected lines are highlighted by changing the colour and thickness of the line and any points associated with the line. The line width and any points shall be increased by 1.5-2 times their normal size.

8. Selected areas are highlighted by placing a coloured outline around the entire area thus changing the colour of its outlines and associated points. The outline width and any points shall be increased by 1.5-2 times their normal size.

9. Primary or pre-selection will remove whatever information is currently in the respective amplification window including contact information. The same guidelines apply as with contact selection.

Source

CSFAB, TBM, DISA, R/SAOC.

Discussion

G4. CFSAB specifies the use of the Advanced Hooking Algorithm for this purpose. A description of the algorithm can be found in Osga [47].

G9. Secondary selection is defined to permit multiple users to hook objects on a single display; access is via a middle input device button. Secondary selection is not addressed in the Guide and is not referenced here.

21.2.4.2 Contact (or object) amplification window

1. Amplifying information for any hooked object is provided via the same amplification area and pop-up windows used for contact information.

2. The contact amplification window shall be a fixed window.

3. The system shall contain a contact amplification window that displays the object information. The operator shall be able to select what amplification information is displayed.

4. A contact amplification pop-up window shall be able to be toggle on and off for both hooked and pre-selected contacts through their respective amplification windows. When the pre-select pop-up window is on, it shall be displayed when the object is pre-selected. The hooked pop-up window may be displayed on selection as determined by the operator.

5. A data block is a special case of amplification. A data block shall contain basic information about a hooked object. Data blocks are used to provide a view of the essential information about objects on the display without requiring that the operator take eyes off of the tactical picture display.

6. If data blocks are implemented they shall have the following characteristics:
   - The data block information shall be presented on a transparent background so as not to obscure the tactical picture.
   - The display of data blocks shall be selectable by the operator.
   - The data block shall be able to be hooked on the display and moved to another portion of the tactical display.
   - The data block shall include a thin line connecting the data block to the object with which it is associated if the data block has been re-located by the operator.
   - The data block shall move with the associated object and shall keep its position relative to the associated object.
   - Information in the data block shall be presented in a fixed order that shall be common to all data blocks of specific types.
   - Display of data blocks shall be operator-selectable.

Source

CSFAB, UCA, R/SAOC.

Discussion

G5. The concept of data blocks is used successfully in a number of systems in both Air Defence and Air Traffic Control.

21.2.4.3 Sequential contact hooking

1. The user shall be able to place the pointer in the location of a group of symbols and successively hook each symbol in a specified range without moving the pointer. As the user presses the sequence function, the next symbol in the group shall be selected. Contacts shall be sequenced in the same order as their layering, with top contacts being sequenced first.

2. A symbol that is currently highlighted in the symbol list shall appear in the visual foreground on the tactical map.

3. The operator shall be able to select a contact by entering its contact number or selecting its name from a list of labelled contacts. The contact shall be highlighted with the selection ring and the selection ring's new position shall be identified to the operator by the location cursor that shall disappear after 2 seconds.

4. Sequential switching shall be able to be toggled off and on by the user with the default being off. If any contacts are overlapping, the contacts are sequentially rotated from top to bottom. Contacts shall be cycled at a default rate of 2 Hz and this rate shall be adjustable by the user.

5. Upon selection of a new object, the previously selected symbol shall be released. Primary selection shall release the primary selected object.

6. The labels on dynamic graphic displays shall remain with the top of the label up regardless of the orientation of the object.

7. The user shall have the capability to obtain exact map coordinates of selected symbol or map features.

Source

CSFAB, DISA, MS1472F.

Discussion

G1. CSFAB recommends an audible cue to indicate that each item in the entire stack of overlapping symbols has been hooked in turn. The requirement for an audible alert has been removed.

G.5 CSFAB indicates that multiple symbol selection is permitted but is not the default.

21.2.4.4 Selecting contacts from tables

1. A columnar list of selectable contacts shall present a symbol graphic, contact descriptor text, ID number, and up to two other database descriptors. This list provides quick access to the most important contacts in the plot. A maximum of nine contacts shall be permitted

in this list. The list shall be sortable by column. When invoked, the list shall appear in a window at the edge of the tactical situation map. The user shall be able to resize, move, and close the list.

2. The selectable contact list shall contain tracks that meet one of several user-determined Flag Force threat, kinematic or descriptive categories such as:
   - all within a specified range
   - hostile surf/sub/air/all
   - military surf/sub/air/all
   - targeted surf/sub/air/all
   - all tracks on display map
   - user-selected track numbers (sorted)
   - surf/sub/air contacts
   - flag force threat category contacts
   - other track descriptive criteria

Source

CSFAB.

21.2.5 Tactical display overlays and filters

1. An automated means shall be provided to register graphic data with background map information at all display scales.

2. Maps shall allow situation display overlays on related map backgrounds. Overlays that obscure data shall not permanently erase any data, and covered data is automatically redrawn if the covering overlay is removed.

3. Map labels and other overlay data shall be positioned consistently (e.g., beneath or within the feature) and all significant features shall be labelled.

4. An option shall be provided to suppress some or all labels on a map display.

5. Map overlays such as country or city names, contact names, road, rivers, or borders shall be able to be toggled on or off by the operator to avoid unnecessary clutter. The operator shall be able to set preferences to toggle these values based on the current range scale.

6. If applicable, elevation features are represented using colour shade coding of a single colour range (for example shades of blue for depth of water), rather than hue coding (i.e., red, yellow, green, etc.). Terrain features identification and classification and operational data may use hue coding. Colours do not change in any window when the focus is shifted from one window to another.

7. Map labels shall remain legible at all display resolutions.

8. Topographic and bathometric data shall be displayed using shading of the land and water colours. Darker shades shall be used for lower elevations and lighter shades for higher elevations.

9. Maps or situational displays shall provide a user-selectable grid overlay that is keyed to the coordinate system of the map.

10. The intensity of the map and overlays shall be adjustable to fade out without losing all map features, while maintaining the brightness of selected overlays.

11. If appropriate to the application, map backgrounds with user-selected overlays (situation displays) may be named for ease of storage, retrieval, modification, display and hard copy.

12. Filters shall be provided and may include Category/ID filters, geographical filters, range and vector filters, attribute filters.

13. Essential contacts that shall not be filtered out of the display include the following: hostile tracks, unknowns, friendly interceptors or fighters, and any track subject to engagement status.

Source

CSFAB, TBM, DISA, Handbook 5.

21.2.6 Maps

1. The curvature of the earth shall be consistently projected on flat surface maps when displaying large geographic areas.

2. When an entire map is not displayed, an inset may be displayed. An inset shall show where the displayed portion is located within the larger map.

3. The inset map shall only show outline features such as political boundaries, shoreline, rivers, lakes, etc.

4. Maps (for example, chart inset windows) that are used solely during the performance of a task shall be located physically near the window(s) associated with the task, and linked to these windows with respect to window layering on the display as a child window. It shall perform in the same fashion as other child windows.

5. When more than one map will be displayed, maps of the same projection shall be displayed throughout the application using the same orientation.

6. All maps shall be oriented such that north is always facing up (north at the top of the display).

7. A map window shall include identifying information about map and status information. This information includes map name, coordinates, area, and/or scale and may be displayed on the map or in a separate associated window. If appropriate to the

application, information on mapping product type, mapping media, and date read, and date created shall be provided.

8. Identifying/status information shall appear in the window area, along the bottom window margin, or in a separate dialog window.

9. Underlying geo-information system or other maps placed on the situation display shall not interfere with the primary (contact or track) information.

Source

CSFAB, TBM, DISA, MH761, UCA.

21.2.7 Tactical display control

21.2.7.1 Map control characteristics

1. Map controls may appear in the map window or are available in separate dialog windows.

2. Map controls shall be commonly located in a horizontal area below the map window.

3. The user shall be able to adjust the contrast of maps and overlays.

4. Users shall be able to define a baseline or home position on a tactical display and return to this position quickly. The default home position shall be Ownship.

Source

CSFAB, TBM, DISA.

Discussion

G4. The requirement was edited to include the default position; the default is consistent with the Halifax-Class CCS and with the Cognitive Task Analysis of the Halifax-Class ORO [48].

21.2.7.2 Panning and zooming

1. The range scale shall be able to be increased or decreased between a continuous range of values not just set increments. Pre-set range options shall be provided for quick access.

2. The base set of ranges for the operators shall at minimum be as follows:

    i. ORO requires 2 to 256 nm

    ii. SWC requires 8 to 256 nm

    iii. ASWC requires 2 to 32 nm

3. A map shall permit the user to change the displayed area by panning or moving a window over the map in any direction.

4. During a panning operation, map windows shall provide an indicator position in the overall map window.

5. During a panning operation, the user shall be provided with the capability to rapidly return to a starting point.

6. A map shall provide a means for moving away from or toward the displayed area (zooming) to obtain a larger view or greater detail.

7. Provide one-button access to a set of pre-set zoom levels.

8. Operators shall be able to quickly zoom a map as desired.

9. Operators shall be able to zoom by either selecting zoom in or zoom out functions that step through standard scales or by using a zoom scale widget.

10. Operators shall also be able to zoom a specific map area by selecting that area with the pointer control device. Panning shall be able to be done through a pan widget.

11. When a map is zoomed, the size of symbols, labels, and other map features shall be adjusted so they remain the same readable size (i.e., symbol size does not change). When zooming, certain objects shall be collapsed or removed depending on the range scale (e.g., City names are displayed if the range is less than 100 miles). This will avoid clutter as the operator zooms into a larger region. The range criteria to collapse or remove objects shall be adjustable by the operator and contain set defaults.

12. If a zoomed region is displayed simultaneously with its respective larger scale map, the zoomed area shall be depicted on the parent map by a coloured outline. The zoomed map window border shall be the same colour as the outlined region.

13. When changing map scales through zooming, a map window shall provide an indicator that continually shows the appropriate scale.

14. Area of the picture must be sufficient to cover the entire area of interest. Zoom values must be appropriate to the size of the area of interest and other sub-areas.

15. A map or other graphic display shall provide an indicator of the scale expansion.

Source

CSFAB, TBM, DISA, UCA.

Discussion

G2. These values were obtained via interview with a small population of operators. The values should be validated before implementing the range scales.

G7. Although DISA suggests that continuous zooming operations are preferred over discrete operations, operators benefit from direct and immediate access to a relevant set of discrete zoom levels.

G12. This will allow for multiple areas to be zoomed simultaneously and for the operator to be able to see where these areas are located in the original map.

G15. MS1472F specifies that the indicator shall be shown when the display is expanded.

21.2.7.3 Tactical display re-play

1. When users play back a situation display, they shall be permitted to set the overall playback rate, stop the playback, start the playback, step quickly forward through the playback (fast forward), and step quickly backward through the playback (reverse).

2. Video, audio or similar playback controls shall be enhanced with text labels for each control.

Source

MH761, UCA.

Discussion

G2. Standard video and playback controls are recommended by MH761. Because these are frequently misinterpreted by users (even though they are a standard throughout a range of industries) the video, audio or similar playback controls need to be enhanced with text labels for each control.

21.2.8 Symbology (map or tactical)

1. The symbology applicable to the CCS shall be consistent with the NTDS, or other conventions as specified. The plotting symbols are presented in *Table 9-1A through C: Plotting Symbols* in NOSTP. The most recent NOSTP document shall be used as reference.

2. Map symbols shall not overlap. Where overlapping symbols are unavoidable a means shall be provided for moving background symbols to the foreground or otherwise revealing masked symbols.

3. Any object on the map display may be selectable as required by the system. Selectable objects other than symbols include: route segments, waypoints, tactical areas, countries, etc.

4. Selected points shall be highlighted by changing the colour of the point and enlarging it to 1.5 times its normal size.

5. Overlapping of symbols and tracks is allowed but total obstruction of any contact is prohibited. At least 25% of the total area of a contact shall be visible at all times. This can be done by offsetting the location of the contact symbol. The symbol location of the lower priority contact shall be offset. When an offset contact is selected, it shall be repositioned in its true location.

6. Symbols shall be overlapped with more important symbols being placed on top. The system shall default to the following threat prioritization from top to bottom: hostiles, unknowns, friends, and neutrals.

7. Priority will be given to air, subsurface, then surface contacts. However, the user shall be able to change the prioritization of contacts. Tools shall be provided to allow the operator to view and access layered contacts.

8. When multiple objects are plotted over the map, the following layering conventions shall be followed (layered from the foreground or top to the background or bottom):

    i. pop-up dialog menus

    ii. waypoints

    iii. route segments

iv. engagement symbol modifiers

v. symbols

vi. hooked and pre-selected contacts

vii. weapon (missile, etc.)

viii. hostile

ix. suspect

x. unknown

xi. assumed friend

xii. friend

xiii. neutral

xiv. IFF (at the same level as its associated contact)

xv. special points

xvi. tactical graphics

xvii. range rings

xviii. air routes

xix. weather

xx. environmental data

xxi. radar returns

xxii. maps

xxiii. borders

xxiv. water

xxv. land

9. The operators shall be able to select the option to display labels for selected symbols.

10. The operator shall be able to select an overlay of specific contacts or groups of contacts that share common characteristics.

11. Map symbols shall be placed accurately on a map or connect to the desired location using arrows, lines, or other graphic pointing methods.

12. Track numbers shall be displayed with both of the two most recent track numbers when track numbers are updated frequently.

Source

CSFAB, TBM, DISA, UCA, NOSTP.

Discussion

G8. TBM prioritizes the contacts as air, subsurface, then surface contacts. The prioritization and layering order should be validated by users before implementing.

G9. The layering conventions should be validated by the users and be consistent with available task analysis data before implementing.

21.2.9 Tactical graphics

1. Tactical graphics allow operators to define meaningful areas such as fly zones, operational areas, waypoints, etc. that are not visually distinguished by the mapping software. Tactical graphics shall be attachable to map objects or specific map coordinates.

2. The operator shall be provided tools for placing tactical graphics on a map. As a minimum the operator shall be able to define rectangles by entering two latitude and longitude sets and define circles by entering the centre latitude and longitude and the radius. The operator shall also be able to define asymmetric regions or lines by entering a series of latitudes and longitudes in a connect-the-dots fashion. If an area is being drawn, the final segment shall be a connection from the last point to the first point. Graphics that are centred on a map object shall use the object's location as an initialization point.

3. Where graphic data entry involves frequent pointing on a display surface, the user interface shall provide display control and sequence control by pointing, in order to minimize shifts from one entry device to another. For example, in drawing a flow chart, a user shall be able to link elements or points directly by pointing at them or drawing lines between rather than by separately keyed entries.

4. A maximum of six colours may be used to display tactical graphics. Designers and users shall include the following guidelines when selecting colours for tactical graphics (unless superseded by explicitly specified symbology conventions).
   - Rust = areas friendlies should avoid
   - Teal = areas friendlies should be located or hostiles should not
   - Gold = areas no contact should be located or areas friendlies may have to go but will be in increased danger
   - Green = commercial or neutral areas
   - Purple/Magenta = areas of no threat significance, reserved for use by the designer and users at their discretion

5. Tactical graphics associated with a contact shall take on the colour family of that contact as in the examples below unless superseded by explicitly specified symbology conventions (see also [19]):
   - Red = Rust
   - Cyan = Teal
   - Yellow = Gold
   - Green = Green
6. Fill patterns are based on the layering and size of the tactical graphics. Large areas shall have less dense fill patterns so as to not overpower other objects on the display. As the default the system shall use the 1/16 dot fill pattern. If a graphic is placed on top of another graphic it shall receive the next denser level of fill pattern. Graphical areas located completely inside another graphical area shall be place on top of that area.
7. Tactical graphics shall be global, shared, or personal. Global means all displays will contain these graphics until removed by the operator. Shared allows other operators to access a graphic someone else has defined. Personal means only the originator of the graphic can display that object.
8. Users shall be able to create personal objects, add shared objects, and shall automatically receive global objects. Operators shall have the option to automatically include shared objects developed by authorized users (e.g., the combat officer may wish to automatically add all shared graphics developed by the team). Users shall be able to edit, reposition, and delete personal items. Shared and global items can only be toggled on and off by all operators. Shared and global items may be altered but are required to be saved as a new object unless the operator is the originator or has authorization to make changes.
9. Any tactical graphic may be attached to a map object, like a symbol, track or another tactical graphic. By attaching a graphic, the graphic follows that object wherever if goes. Attached graphics shall be generated by selecting the object and issuing an “attach graphic” command. A new graphic may then be developed or an existing graphic may be attached. The graphic shall be centred on the contact as a default but this option may be toggled off by the operator.
10. The operator shall have the ability to toggle on and off information (e.g., speed leaders, IFF symbols, track history, and tactical overlays) to display only the information useful to the task.
11. IFF symbols shall always be oriented vertically.
12. The size of IFF symbols shall be selectable between two sizes. The same sizes shall be used for associated alphanumeric symbols with a height/width ratio of 1:1 to obtain maximum legibility of capital letters.
13. Use the IFF symbol's centre as its exact location on the tactical display. This point shall be offset from the associated contact symbol or radar return. The offset shall be on a bearing line from own ship to the associated track or radar return and shall be beyond the associated track or radar return by a standard number of pixels that is adjustable by the operator.

14. Colour recommendations for IFF symbols are based on task requirements. Provide the operator with an option of four colour, two colour, or monochrome (off-white or white) IFF symbols. Provide a one pixel, black outline around each symbol so it does not lose it shape in a cluttered environment. In a two colour mode the colour magenta is used for the Passive Decode, I/P, Mode 4, and emergency symbols. The remaining IFF symbols are coloured off-white or white.

15. Alphanumeric coding shall be used to denote passive decodes. However, do NOT use “A”, “V”, “O”, “Q”, or “U” as they may be mistaken for outline contact symbols. Confusion may occur between “A” and hostile air contacts, “V” and hostile subsurface contacts, “O” or “Q” and friendly surface contacts, and **“**U**”** and friendly subsurface contacts.

Source

CSFAB.

Discussion

G14. A four-colour scheme for IFF symbols introduces undue complexity into the ORO, SWC, and ASWC displays and so is not included here.

21.2.10 Uncertainty

1. Contact uncertainty may be displayed to show the operator the system’s confidence in the contact information. The range of uncertainty may be displayed as the maximum and minimum or within a certain confidence interval. The most effective uncertainly displays are intuitive.

2. Graphics conveying uncertainty shall use fuller (or larger) symbols to represent higher levels of certainty; less full (or smaller) symbols shall be used to represent less certainty.

3. Display of uncertainty shall be consistent with the recommendations resulting from the most current applicable research.

Source

CSFAB, UCA.

Discussion

G1. Before implementing an aid of this nature, its operational effectiveness should be validated. Some attempts to assist the operators by displaying the level of uncertainty add clutter without substantially aiding the operator.

G2. This guideline is based on the results from a Symbology and Design Study conducted under the COMDAT TDP [49]. In that study, it was determined that operators who participated in the study viewed larger symbols or fuller symbols as representing MORE certainty. While larger objects are generally perceived as more important than smaller objects, there appears to be a conflict between representations of certainty and importance. It is recommended that increased size in symbols be reserved to draw attention to important information (such as errors or dangerously low ammunition reserves) rather than to convey certainty. For displays of certainty, larger symbols are intuitively interpreted as conveying more certainty and newly developed symbology should be consistent with the operators' intuitive mental models.

G3. The original CFSAB guidelines included specific recommendations for representing location and bearing uncertainty. Since the basis for those recommendations was not clear, it was decided not to include them. Examples of uncertainty symbols that have been tested using CF personnel can be found in [49] and [50].

21.2.11 Saving preferences

1. Operators shall be provided the ability to set map preferences to that of any saved map. Saved maps can be any map configuration that is saved by an operator under a given title. Only map view, map detail, tactical graphic, and special point information are stored for a saved map. Track and radar appearance are always specific to the situation and the operator's workstation.

2. If information will be lost by changing from one map to another, the operator shall be given the option to retain that additional information. Operators shall have quick access to a series of selected saved maps to provide commonality at the appropriate command levels. These are the group, ship, team, and personal maps. If an operator resaves a map, its new preferences shall only be seen by others using that map if they re-select the map.

3. A standard set of default map preferences will be used for the personnel, team, and ship maps until they are defined. The default map is a global default for all operator positions in a defined group. Only specified users may alter the preferences of a default map.

4. The group commander will be able to select any saved map as the group map for all those under his/her command. Only specified users may alter the preferences of a group map.

5. The combat system commander will be able to select any saved map as the ship map for all those under his/her command. Only specified users may alter the preferences of a ship map.

6. Team leaders will be able to select any saved map as a team map for those under his/her command. Only specified users may alter the preferences of a team map.

7. All operators shall have the ability to select any saved map as their personal map including other personal maps. Choosing a saved map as a personal map resaves that map's preferences under a personal file. This avoids personal maps being altered if changes are made to a saved map.

8. If maps and/or situation displays are stored, or if more than one map and/or situation display appears in an application, an index shall be available.

Source

CSFAB, TBM.

21.3 Tactical pop-ups

1. The pop-up menu shall contain functions most commonly used with the related object. The map pop-up window will be the default pop-up menu if no other object is under the pointer.

2. Each pop-up menu shall be organized in three sections as follows:
   - Top Section-Action
   - Middle Section-Display Attributes, Specific
   - Bottom Section-Display Attributes, Global

3. The following organization of pop-up menu contents shall be used whenever the contents are applicable:
   - Map Controls Pop-Up
     - Zoom In
     - Zoom Out
     - Zoom Box
     - Pan
     - Centre Map
     - Borders
     - Detail
     - Topography
     - Colours
   - Radar Pop-Up
     - Radars Available
     - Returns
     - Fade

    - Sweep
    - Appearance
    - On/Off
- Tactical Graphic Pop-Up
    - Coordinates
    - Info/Label
    - Appearance
    - Sharing
    - Remove
- Segment/Waypoint Pop-Up
    - Coordinates
    - Info/Label
    - Remove
- IFF Pop-Up
    - Mode 4 Interrogate
    - Stretch
    - Size
    - Colours
    - Offset
    - On/Off
- Contact Pop-up
    - Engage
    - Drop
    - Interrogate
    - Communicate
    - Info/Label
    - Prominence
    - Uncertainty
    - Speed Leaders
    - Appearance
    - Symbol
    - History Points
    - Range Circles
    - Dead Reckon (DR)

- DR Trailer
- Other

4. Pop-up menus sorted by contacts within a user-specified range of the pointer shall be available to aid in contact selection from a group. If the sorted pop-up menu capability is required it shall be implemented as follows:
   - The default range shall be a radius of 1/20 the shortest tactical display dimension (If the tactical display is 12" by 10", the range would be a radius of 10" x 1/20 =0.5" around the pointer).
   - Display of the pop-up menu shall be user-invoked by holding the select button for a user-specified period. The default time shall be 0.5 seconds.
   - Upon activation, a circle of the specified range shall be displayed around the pointer along with the pop-up menu.
   - The pop-up menu shall be displayed in the immediate vicinity of the pointer without overlapping the range circle.
   - The pop-up menu shall show a columnar listing including all contacts in the specified range and allow user selection of contacts from the menu.
   - Each row on the menu shall contain the symbol contact ID number, a graphic picture of the symbol, and a short noun descriptor e.g., tanker, or other information appropriate to Canadian C2.
   - Selecting a contact in the menu shall also select that contact on the display and bring it to the foreground.

Source

CSFAB, UCA.

Discussion

Before implementing tactical pop-up menus the tactical benefit of each pop-up and each item in the pop-up should be validated for Canadian Maritime operations.

Evaluation methods and measures

Design verification:

- Verification of visibility of information, ease of use, and design consistency of all maps and situation displays and associated controls and tools.
- Operator performance:
- Objective assessment of use and usefulness of all maps and situation displays and associated controls through usability.
- Objective assessment of speed and accuracy of detection and recognition of critical objects and information on maps and situation displays.

Operator acceptance:

- Subjective assessment of the adequacy of the operator's perceptions of usability and utility of maps and situation displays and associated controls and tools.
- Assessment of the intuitiveness of uncertainty representations and symbolic information in the OMI.

Operator decision making quality:

- Assessment of timeliness and agility of decision making using scenario-based studies.
- Assessment of situation assessment capabilities using scenario-based studies.

Operator situation awareness:

- Subjective assessment of the adequacy of the operator's situation awareness of the recognized maritime picture.

22 Colour

22.1 Overview

Colours are used to convey specific information. The use of colour coding should be kept to a minimum. The use of too many colour codes will reduce the likelihood that significant colour coding will be interpreted quickly and accurately by users. Colour is only an effective coding scheme when an object has eight or less possible states. Colour is most advantageous when an operator must segregate or search for objects in a cluttered and unformatted display, like finding enemy contacts in a tactical plot.

Colours must be evaluated in the complete context of the display; colours are subject to perceptual shifts in appearance depending on their context. Perception of colour also changes depending upon lighting conditions.

Two conditions of ambient lighting are used in the Halifax-Class control room. These lighting conditions are the following:

- Normal operations room lighting (dim lighting)
- Dark adaptation conditions (red lighting)

To maintain dark adaptation red lighting is used. In future, other colours of light may be used instead of red to maintain dark adaptation (e.g., blue) and other ambient lighting may be used for normal operations room lighting (e.g., daylight or office lighting). The OMI should be developed to include sets of colours for each of the lighting conditions in the operations room. The operators will then be able to choose the optimum display for the appropriate set for the conditions.

This section includes colour guidance for the windows colours and the tactical display graphics. See Section 21.1: Radar for guidance on colour display of raw radar.

22.2 Colour sets

1. Colour coding for the windows and tactical display shall follow the guidance presented in [51] when ambient lighting is between 7-200 (20-300) lux. These colours were chosen to minimize operator eyestrain that can occur when viewing a monitor that is much brighter than the environment.

2. If ambient room lighting is above 300 lux then a light colour scheme shall be used.

3. In a dark adaptation environment, a dark colour set (see [51]) shall be tailored for optimized usability under the specific lighting conditions.

4. Users shall be able to select between colour sets: One set shall be provided for each of the lighting conditions in the operations room (e.g., normal operations room lighting and dark adaptation lighting).

5. The operator shall have the options to select between colour sets for each applicable lighting condition but shall not otherwise adjust the individual colours in the display.

6. The colour sets for the displays must be unambiguous and retain cognitively consistent colour coding conventions under all lighting conditions.

7. Changing to an alternate colour set shall not alter security classification colours.

8. In dim environments (most operations rooms, ship's bridge at night, submarines), a dark background is better for maintaining proper contrast ratios between the screen and the room objects.

9. If users must look back and forth between monitors, papers, status boards, windows, etc., the contrast ratio between any of these objects and the monitor's average luminance shall not exceed 40:1 with a preferred value of 20:1.

Source

CSFAB, TBM, MSWUE, UCA, HFDATC.

Discussion

G1. It shall be noted that such dark environments are not optimal for the viewing of colours, reading of printed documents, or face-to-face communications. Given that all of these activities commonly occur in Operations Rooms, an ambient lighting level of 100-500 lux is recommended.

G3. S52, Appendix 2, Specifications for chart content and display aspect of ECDIS, [51] includes colour sets for all levels of ambient illumination. The night set is designed to preserve dark adaptation.

G5. TBM permits more colour customization.

G6. A small number of selectable colour sets has been used successfully by the Icelandic Civil Aviation Authority and for Electronic Chart Display Information System (ECDIS) [51].

22.3 Specific colour use

1. Colour pairs at spectral extremes (e.g., red/green, yellow/purple) shall not be used together because they appear to vibrate when placed next to each other.

2. Pure white text shall not be displayed on a pure black background because this combination produces an effect known as halation, which makes text less readable.

3. Because the human eye has difficulty focusing on blue, very saturated or pure shades of blue shall not be used for text or for any critical information.

4. Red shall be used to indicate critical or irreversible options.

5. Red shall be used to alert the operator that an application/process is inoperative until corrective action is taken.

6. Yellow codes shall be used only to alert to situations involving caution, recheck, or unexpected delay.

7. Black shall not be used as the background for colour-coded items.

8. Background colours shall be unsaturated hues (e.g., tan, off-white) and shall not be pure white.

9. Symbology shall be colour coded using the following conventions, unless superseded by NTDS [19] or other explicitly specified symbology conventions:

   - hostile: red (or magenta)
   - friend: blue (or cyan)
   - unknown: yellow
   - neutral: green

10. The Halifax Class CCS specifies white symbology to denote computer-identified contacts. The CCS specification shall be followed unless superseded by specified symbology conventions.

11. Areas are highlighted in different manners when hooked depending on the shape of the object. The distinction between primary, secondary, or pre-selected objects shall be made by the highlight colour.

Source

CSFAB, TBM, DISA, UCA.

Discussion

G10. The specification for white symbols in the Halifax-Class CCS should be verified.

22.4 Colour guidelines

1. Colour shall be used only when it will increase operator performance or situational awareness.

2. Borders between different land types, water, and coastal borders shall be consistent with the conventions presented in [51].

3. A maximum of three land and three water colours shall be used. Exceptions may include topographic and bathometric data if appropriate shading does not negatively impact operations.

4. The number of colours used to code the information for graphical displays shall not exceed nine since users have difficulty discriminating among more than this number of colours.

5. The number of colours used to code the information for alphanumeric display shall not exceed seven, and only four codes shall be displayed at any one time.

6. Colour shall be used for coding, to highlight, aid in grouping, or to clarify relationships.

7. When colour is used to enhance action icons, the colours shall be consistent with Microsoft Windows conventions.

8. Colour coding may be employed to differentiate between classes of information in complex, dense, or critical displays.

9. Colour shall be used consistently within an application and between applications in a system.

10. Colours used for displaying status shall be the same throughout the application and restricted to that function.

11. Colour used in predefined message windows shall only be used in the symbol/icon and shall not be used for text.

12. If colour is used to convey meaning, it shall be used redundantly and shall not be the only coding technique.

13. If colour coding is used, each colour shall represent one category of displayed data.

14. If the operator must focus on different types of objects in the display for different tasks, the operator shall be given the ability to use variable coded symbology (e.g., only colour code contact symbols or only colour code IFF symbols).

15. Slight shade changes in colour shall not be used to show gradation or choice. Exceptions may include topographic and bathometric data if appropriate for operations.

16. The background colour behind the text shall not be used to show a change in the system status. This is because changing the background colour usually reduces the readability of the text. Instead, change in system status shall be identified by changing the colour of an object next to the text.

17. Colour code customization shall be only permitted for information that is not tactically significant.

18. Unobtrusive colours shall be used to display information used infrequently. Warm colours (those with longer wavelengths, such as red or orange) shall be used to convey action or the requirement for a response.

19. Cool colours (those with shorter wavelengths, such as blue or green) shall be used to convey status or background information.

20. Wavelengths above 650 nm shall be avoided if the operators include protanopes.

Source

CSFAB, TBM, DISA, MS1472F, MSWUE.

Evaluation methods and measures

Design verification:

- Verification of consistency of use and reproduction and visibility of luminance and chromaticity of all colours used on the display.

Operator performance:

- Assessment of the visibility, discriminability, and recognition of all colours used in the OMI.

Operator acceptance:

- Assessment of the intuitiveness of colour coding used in the OMI.

23 Design and evaluation

23.1 Adopt operator-centered design principles

1. The design of an ESS shall begin by choosing the human-centered criteria (goals) of the system and then defining the functions that the system will perform.

2. Standard operating procedures and company policies shall guide system designers in the appropriate allocation of a task to the operator or the ESS, although the operator shall be ultimately responsible to make the decision to use or not use the automation.

3. A substantial proportion of the operators shall be involved in the design of the ESS.

4. The ESS shall be based on operator population characteristics (cognitive and heuristic biases, skills, experience, and training) and cognitive processes (mental representation and decision strategy) of the operator.

5. The unique contextual and environmental considerations shall be incorporated into the design of the ESS to support decision making.

6. When a new ESS technology is introduced, the designers shall consider the possibility of negative effects on team coordination.

7. The overall impact of an ESS shall be thoroughly examined before implementation to ensure that changes do not result in additional complexities, loss of situation awareness, or possibilities for error.

8. The ESS shall keep an up-to-date record of where the operator currently is within a sequence of tasks or activities.

9. Organize the functionality of the ESS in line with the operator's tasks.

10. ESS-related information shall be structured according to the operator's task.

Source

HFDS, DEFSTD25, AHCI, DISA, Zachary97, MS1472F.

Discussion

G1. An operator-centered design process is a highly structured, comprehensive product development methodology driven by (1) clearly specified, task-oriented objectives and (2) recognition of operator needs, limitations and preferences. Information collected using this analysis is scientifically applied in the design, testing and implementation of an ESS. Defining the goals and functions of an ESS may require the use of a mission, function and task analysis.

G2. Input from the operator is essential in defining information requirements. To increase the likelihood that the new system will "fit" most operators and the constraints of their tasks, a representative number of operators shall be involved to provide advice and feedback in the

development of the system. Not only shall this help with system development, but it shall also give a reasonable number of operators a feeling of “ownership” which they can transmit to their colleagues, thereby helping to facilitate the development of trust.

G6. Automation of tasks may deplete team interaction and cooperation unless all parties are provided with information that allows them to be actively involved in the task. Task automation can cause physical difficulty in seeing what the other team member is doing, reduce the ability to cross monitor, change traditional roles and responsibilities, and change the manner in which team members attempt to help one another.

G8. This allows the operator to resume tasks smoothly and efficiently after being interrupted.

G9. Information objects and operations shall be accessible in a sequence that matches the way operators will most effectively and productively do things with minimal error.

G10. Essential information that is regularly needed, cross-checked, or time-critical should be prominently displayed. Less essential information can be less prominently displayed, or minimized, pending examination at another time.

Evaluation methods and measures

Design verification:

- Verification that design methodology is compliant with MIL-HDBK-46855A (Human Engineering Program Process and Procedures) [26].
- Verification of system usability and utility.

Operator acceptance:

- Assessment of the adequacy of operator’s perceptions of system usability and utility.

Relationship to other guidelines

7.1.1 Employ operator centered principles

7.2 Employ operator-centered OMI design

23.2 Adopt operator-centered evaluation principles

1. Possible interactions with other tools, system functions, and operator tasks shall be evaluated when a new ESS is designed.

2. New ESS components shall be tested with the complete system, including other system components of the ESS, to ensure they function together as an effective whole.

3. The ESS shall be tested under normal modes of operation and under failure modes of operation.

4. Contextually valid human-in-the-loop experiments and simulations shall be conducted to validate and refine the ESS design.

5. Evaluations of the usability of the system shall be carried out at all phases of the system development.

6. The ESS shall be tested in a realistic operational environment using tasks and operators representative of the final system.

Source

HFDS, DEFSTD25.

Discussion

G5. These evaluations shall be used both to assist in deciding between alternative design options, and to support validation that the design satisfies the system's operability requirements.

G6. The tasks shall provide reasonable coverage of the most important parts of the system. The test tasks can be designed based on a task analysis or on a product identity statement listing the intended uses for the system.

Evaluation methods and measures

Design verification:

- Verification that evaluation methodology is compliant with MIL-HDBK-46855A (Human Engineering Program Process and Procedures) [26].

24 Training and implementation

24.1 Manage introduction of the ESS

1. An ESS shall be introduced with advanced briefing and subsequent training.

2. Before the ESS is introduced, operators shall be informed of associated changes and increases in the work effort, as well as the benefits associated with the ESS.

3. Operators shall be trained to acquire an adequate understanding (mental model) of how the ESS works in order to use it effectively.

4. Training programs shall stress human-system interaction skills and cognitive/problem solving skills rather than psychomotor skills.

5. When the ESS requires different kinds of cognitive processing, ways of thinking, and discarding of traditional methods and skills, training shall be designed to address problems related to these changes.

6. Operators shall be trained on what constitutes the normal ESS output so that the operator can easily determine whether the system is functioning properly.

Source

HFDS, DEFSTD25 Parasuraman97, Zachary97, DISA.

Discussion

G1. The introduction of the ESS may introduce changes in traditional roles and responsibilities, a redistribution of authority for tasks or changes to the nature of the cognitive demands imposed on the human operator.

G2. The roles and responsibilities of the operators, cognitive demands, and operational procedures may change as a result of introducing automation.

G3. Operators must possess accurate mental models of the system in order to use it effectively, comprehend current situations, plan their actions, predict future system states and diagnose system failures.

G4. Problems in automation may not be inherent in the technology itself. Problems can arise due to limitations in the integration of the operator and automation.

Evaluation methods and measures

Design verification:

- Verification that training plan includes Training Needs Analysis (TNA).
- Verification that training plan compliant with MIL-HDBK-46855A [26] guidance for training (i.e., minimize training requirements).

- Verification that training plan includes regular training evaluations.

Operator acceptance:

- Subjective assessment of the adequacy of operator's acceptance of ESS.
- Subjective assessment of the adequacy of operator's perception of ESS usefulness.

Relationship to other guidelines

24.2 Train to overcome automation biases

24.3 Train to overcome ESS failures

24.4 Promote operator acceptance and trust in ESS

24.2 Train to overcome automation biases

1. Operators shall be trained to recognize inappropriate uses of an ESS including automation bias (the use of automation in a heuristic manner as opposed to actively seeking and processing information).

2. Operators shall be trained to recognize and understand the conditions under which the system may be unreliable, and to learn the conditions where it performs well (when or when not to question the automation).

3. Operators shall be trained not to become overly reliant on automation.

Source

HFDS, DISA, Parasuraman97.

Discussion

G1. There are different categories of inappropriate automation use, including automation bias, ignoring or turning off the automation, and improper implementation of automation. Operators may rely on decision aids in a heuristic manner (referred to as automation bias). Using heuristics is to apply simple decision-making rules to make inferences or to draw conclusions simply and quickly. Heuristics are useful principles having wide application, but may not be strictly accurate. Usually a heuristic strategy is optimal, however, under certain conditions heuristics will be inappropriate and errors or misuse may occur. Automation bias leads to errors of omission (failure to notice system anomalies when automation fails) and errors of commission (acceptance of automated decisions without cross-checking or in presence of contradictory information). Training will help prevent automation bias and help the operator learn to examine multiple sources of information before making a decision. Early training on automation bias may reduce commission errors for operators new to automation, but may be less likely to reduce omission errors or errors made by expert operators. Inappropriate use of automation may be influenced by various individual factors such as self-confidence in completing the task, trust in the automation, differential effects of fatigue, and how all of these factors combined weigh into the decision making process. Inappropriate use of automation can be due to misuse (automation bias, complacency), disuse (ignoring or turning off automation) or abuse (improper implementation of

automation).The roles and responsibilities of the operators, cognitive demands, and operational procedures may change as a result of introducing automation.

G2. Operators must learn not to categorically accept the recommendation of a decision aid. Understanding the automation's weaknesses allows operators to better judge how much they shall trust the automation without becoming overconfident in its performance. This recognition process may impose an additional workload on the operator.

G3. When operators rely on automation too much they become susceptible to automation-induced complacency. Monitoring failures are likely to occur when operators become overly reliant on automation.

Evaluation methods and measures

Design verification:

- Verification that training plan includes TNA.

Operator decision making quality:

- Subjective assessment of the adequacy of the quality of the operator's situation assessment processes.

Operator trust:

- Subjective assessment of the adequacy of operator trust.

Relationship to other guidelines

24.1 Manage introduction of the ESS

24.3 Train to overcome ESS failures

24.4 Promote operator acceptance and trust in ESS

24.3 Train to overcome ESS failures

1. Operators shall be trained on risk assessment and actions needed for risk reduction.
2. Operators shall be trained on transitioning from the ESS to manual operations.
3. Operators shall be trained to ensure proper understanding of the ESS's processes.

Source

HFDS, AHCI, Endsley96, Parasuraman97.

Discussion

G2. If the ESS was to fail, operators need to be skilled at both recognizing the failure and taking manual control.

Evaluation methods and measures

Design verification:

- Verification that training plan includes TNA.

Operator performance:

- Objective assessment of the adequacy of the operator's ability (e.g., speed and error) to resume manual control.
- Objective assessment of the adequacy of the operator's ability (e.g., speed and error) to detect and manage ESS failures.

Relationship to other guidelines

24.1 Manage introduction of the ESS

24.2 Train to overcome automation biases

24.4 Promote operator acceptance and trust in ESS

24.4 Promote operator acceptance and trust in ESS

1. Training shall be provided to enable the operator to calibrate their trust in the ESS.
2. Changes in cognitive processing, ways of thinking, and methods and skills used for the ESS shall be minimized.
3. To promote operator acceptance, operators shall be trained to ensure proper understanding of the system's processes.

Source

HFDS, DEFSTD25, MS1472F, Parasuraman97.

Discussion

G1. Training will allow the operator to develop an adequate model of how reliable or unreliable the ESS is under specific conditions.

G2. An ESS that requires different kinds of cognitive processing, ways of thinking, and discarding of traditional methods and skills may cause the system to be both less efficient and less acceptable to the operators. This could include automatic conversion of data into a usable format.

G3. The better the operator understands the ESS, the more likely the operator is to trust the ESS appropriately. Designers need to alter the false belief that an ESS isperfect and ensure that the operators understand when the system is likely to become unreliable.

Evaluation methods and measures

Design verification:

- Verification that training plan includes TNA.
- Verification that training plan includes regular training evaluations.

Operator acceptance:

- Subjective assessment of the adequacy of operator's acceptance of ESS.
- Subjective assessment of the adequacy of operator's perception of ESS usefulness.

Operator trust:

- Subjective assessment of the adequacy of operator trust.

Relationship to other guidelines

24.1 Manage introduction of the ESS

24.2 Train to overcome automation biases

24.3 Train to overcome ESS failures

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List of symbols/abbreviations/acronyms/initialisms

3D	3-Dimensional
ASWC	Assistant Sensor Weapons Controller
AWW	Above Water Warfare
C2	Command and Control
CPA	Closest Point of Approach
CCS	Command and Control System
COMDAT	COMmand Decision Aiding Technology
DR	Dead Reckoning
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
ESS	Electronic Support System
FAB	Fast Action Button
FASA	Factors Affecting Situation Awareness
IFF	Identify Friend/Foe
INCOMMANDS	Innovative Naval COMbat MANagement Decision Support
M button	Menu button: the right button on a three-button mouse (see section 9.3.3)
NASA-TLX	National Aeronautics and Space Administration - Task Load Index
NOSTP	Naval Operations School Training Publication
NTDS	Naval Tactical Data System
OMI	Operator Machine Interface
ORO	Operations Room Officer
OSF	Open Source Format
QAB	Quick Action Button
R&D	Research & Development
S button	Select button: the left button on a two- or three-button mouse (see section 9.3.3)
SA	Situation Awareness
SAGAT	Situation Awareness Global Assessment Technique
SART	Situation Awareness Rating Technique
STANAG	Standardization Agreement
SWC	Sensor Weapons Controller

T button	Transfer button: the middle button on a three-button mouse and the right button on a two-button mouse (see section 9.3.3)
TAM	Technology Acceptance Model
TBM	Theatre Battle Management
TD	Technology Demonstrator
TDP	Technology Demonstrator Program
TEWA	Threat Evaluation and Weapons Assignment
TNA	Training Needs Analysis

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(U) The Innovative Naval COMbat MANagement Decision Support (INCOMMANDS) Technology Demonstration Program (TDP) seeks to research, demonstrate and evaluate new command decision support concepts for the HALIFAX Class frigate's command and control (C2) system, with the objective of improving team battlespace awareness and increasing decision speed and accuracy. This work necessitates the design, development and evaluation of innovative Operator Machine Interface (OMI) concepts to support the operator's interaction with the command decision support concepts developed by the project team. The aim of this document is to incorporate recommended standards and guidelines that should guide and inform the design of OMI and decision aiding concepts developed within the INCOMMANDS project so that they are consistent with human factors best−practice. The document includes guidance on creating a common look and feel that is compatible with existing systems, yet accommodates new developments and knowledge and the design and implementation of decision aids that are both useful and useable. In addition, guidance is provided on the selection of metrics and tools for the evaluation of both the OMI and decision aids for compliance.

(U) Le programme de démonstration technologique (PDT) du concept INCOMMANDS (Innovative Naval COMbat MANagement Decision Support, ou Système novateur d'aide à la décision pour la gestion du combat naval) vise à étudier, à démontrer et à évaluer de nouveaux concepts d'aide aux décisions de commandement pour le système de commandement et de contrôle (C2) de la frégate de classe HALIFAX, dans l'intention d'améliorer la connaissance collective de l'espace de bataille et d'augmenter la rapidité et la justesse des décisions. Ces travaux exigent la conception, l'élaboration et l'évaluation de principes novateurs d'interface opérateur−machine (IOM) pour appuyer l'interaction de l'opérateur avec les concepts d'aide aux décisions de commandement élaborés par l'équipe du projet. Ce document a pour but d'intégrer des normes et des lignes directrices recommandées, qui guideront et façonneront l'élaboration des concepts d'IOM et d'aide à la décision arrêtés dans le cadre du projet INCOMMANDS de sorte qu'ils correspondent aux meilleures pratiques des facteurs humains. Le document intègre des lignes directrices en vue de la création d'une présentation uniforme qui soit compatible avec les systèmes existants, tout en tenant compte des derniers développements et de l'état des connaissances pour la conception et la mise en œuvre d'aides à la décision à la fois utiles et utilisables. On y trouve également des lignes directrices sur le choix des indicateurs et des outils permettant d'évaluer la conformité de l'IOM et des aides à la décision.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

(U) INCOMMANDS; guidelines; Threat Evaluation and Combat Power Management (TEWA); OMI Design; decision support; operator machine interface; human factors; evaluation methods; electronic support system

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